REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average. Shour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this solicetion of information, including suggestions for reducing this ourcent to Washington Headquarters Services, Directorate for information Operations and Reports, 1215 Jefferson Dazis Highway Suite 1204. Arrington: 7A 2202-4102 and to the Office of Management and Budget. Paperwork Reduction Projection 2018, Washington, 2018.

Davis Highway, Suite 1204 Arrington, VA 22202-4			
1. AGENCY USE ONLY (Leave blank		3. REPORT TYPE AND DA	
4. TITLE AND SUBTITLE	JUNE 1995	Final Remedial Inv	estigation UNDING NUMBERS
Installation Restoration Progr Alpena Combat Readiness Tra Alpena MI 6. AUTHOR(S)			RTDVG957097
N/A			
7. PERFORMING ORGANIZATION NA	ME(S) AND ADDRESS(ES)		ERFORMING ORGANIZATION EPORT NUMBER
EARTH TECH Oak Ridge TN			EPORT NOWBER
9. SPONSORING / MONITORING AGEN	ICY NAME(S) AND ADDRESS(ES	10. 5	PONSORING / MONITORING
Hazardous Waste Remedial A Martin Marietta Energy Syste Oak Ridge, TN 37831	9		GENCY REPORT NUMBER G-07-159-0370
		DTIC_	
11. SUPPLEMENTARY NOTES		JUL 1 4 1995	
12a. DISTRIBUTION / AVAILABILITY ST	ATEMENT	12b.	DISTRIBUTION CODE
Approved for public release; distribution is unlimited			
13. ABSTRACT (Maximum 200 words) Remedial Investigation Report A remedial investigation was proported to the sites. The 2 Motor Pool Area; Site 3 Form Area; Site 6 Former Landfill; Sites Storage Area. Soil and sites. An FS has been initiated	t of Sites 1-9 at Alpens CR performed on 9 sites at the e sites involved in this inv ner Garage; Site 4 Third F Site 7 First Fire Training A groundwater contamination	e Alpena CRTC to determi vestigation include: Site 1 : Fire Training Area; Site 5 : Area; Site 8 Former Hange	ne the extent of POL Storage Area; Site Second Fire Training er 9; Site 10 Hazardous
		DTIC QUALITY IN	SPECTED 5
14. SUBJECT TERMS			15. NUMBER OF PAGES
Installation Restoration Progr Alpena CRTC; Alpena MI , An		Remedial Investigation;	284 16. PRICE CODE
17. SECURITY CLASSIFICATION 18	S. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATIO OF ABSTRACT	N 20. LIMITATION OF ABSTRACT
	UNCLASSIFIED	UNCLASSIFIED	NONE

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to stay within the lines to meet optical scanning requirements.

- Block 1. Agency Use Only (Leave blank).
- **Block 2.** <u>Report Date</u>. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.
- Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 30 Jun 88).
- Block 4. <u>Title and Subtitle</u>. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.
- Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C - Contract PR - Project
TA - Task
PE - Program
Element WU - Work Unit
Accession No.

- **Block 6.** Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).
- **Block 7.** <u>Performing Organization Name(s) and</u> Address(es). Self-explanatory.
- **Block 8.** <u>Performing Organization Report Number</u>. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.
- **Block 9.** Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.
- Block 10. <u>Sponsoring/Monitoring Agency</u> <u>Report Number</u>. (If known)
- Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. <u>Distribution/Availability Statement</u>. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

DOD - See DoDD 5230.24, "Distribution Statements on Technical Documents."

DOE - See authorities.

NASA - See Handbook NHB 2200.2.

NTIS - Leave blank.

Block 12b. Distribution Code.

DOD - Leave blank.

DOE - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.

NASA - Leave blank. NTIS - Leave blank.

- **Block 13.** Abstract. Include a brief (Maximum 200 words) factual summary of the most significant information contained in the report.
- **Block 14.** <u>Subject Terms</u>. Keywords or phrases identifying major subjects in the report.
- **Block 15.** <u>Number of Pages</u>. Enter the total number of pages.
- **Block 16.** <u>Price Code</u>. Enter appropriate price code (NTIS only).
- Blocks 17. 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.
- Block 20. <u>Limitation of Abstract</u>. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

INSTALLATION RESTORATION PROGRAM

FINAL REMEDIAL INVESTIGATION REPORT

VOLUME V: APPENDICES P - W

ALPENA COMBAT READINESS TRAINING CENTER
ALPENA COUNTY REGIONAL AIRPORT, MICHIGAN AIR NATIONAL GUARD
ALPENA, MICHIGAN

JUNE 1995



HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM Environmental Restoration and Waste Management Programs

Oak Ridge, Tennessee 37831-7606
managed by MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the U.S. DEPARTMENT OF ENERGY under contract DE-AC05-840R21400

TABLE OF CONTENTS

REMEDIAL INVESTIGATION REPORT ALPENA COMBAT READINESS TRAINING CENTER MICHIGAN AIR NATIONAL GUARD ALPENA, MICHGIAN

Volume V

Appendix

P Site 1 Risk Assessment

O Site 2 Risk Assessment

R Site 3 Risk Assessment

S Site 4 Risk Assessment

T Site 5 Risk Assessment

U Site 6/7 Risk Assessment

V Site 8 Risk Assessment

W Site 9 Risk Assessment

Accesi	on For	
DTIC	ounced	
By Distrib	ution /	
A	vailability (Codes
Dist	Avail and Specia	
A-1		-

Table P-1A

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Groundwater - Site 1

MIANG, Alpena CRTC, Alpena, MI

SITE	LOCATOR	SAMPLE ID	MATRIX	ANALYTE	RESULT
PC.P1	MV1	PC-P1-MW1-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-P1	MW11	PC-P1-MW11-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-P1	MW14	PC-P1-MW14-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0820
PC-P1	MW6	PC-P1-MW6-GW4	GROUNDWATER	1,4-Dichlorobenzene	25.0000
PC-P1	MW1	PC-P1-MW1-GW4	GROUNDWATER		17.5000
PC-P1	MW11	PC-P1-MW11-GW4	GROUNDWATER	Antimony, Dissolved	39.2000
PC-P1	MW12	PC-P1-MW12-GW4	GROUNDWATER	Antimony, Dissolved	17.5000
PC-P1	MW13	PC-P1-MW13-GW4	GROUNDWATER	_	17.5000
PC-P1	MW14	PC-P1-MW14-GW4	GROUNDWATER	Antimony, Dissolved	17.5000
PC-P1	MW2	PC-P1-MW2-GW4	GROUNDWATER	Antimony, Dissolved	17.5000
PC-P1	MW3	PC-P1-MW3-GW4	GROUNDWATER	Antimony, Dissolved	17.5000
PC-P1	MW4	PC-P1-MW4-GW4	GROUNDWATER	Antimony, Dissolved	17.5000
PC-P1	MW6	PC-P1-MW6-GW4	GROUNDWATER	Antimony, Dissolved	39.2000
PC-P1	MW1	PC-P1-MW1-GW4	GROUNDWATER	Benzene	13.0000
PC-P1	MW11	PC-P1-MW11-GW4	GROUNDWATER	Benzene	0.6000
PC-P1	MW12	PC-P1-MW12-GW4	GROUNDWATER	Benzene	0.1750
PC-P1	MW13	PC-P1-MW13-GW4	GROUNDWATER	Benzene	0.1750
PC-P1	MW14	PC-P1-MW14-GW4	GROUNDWATER	Benzene	0.1100
PC-P1	MW2	PC-P1-MW2-GW4	GROUNDWATER	Benzene	0.1750
PC-P1	MW3	PC-P1-MW3-GW4	GROUNDWATER	Benzene	0.0900
PC-P1	MW4	PC-P1-MW4-GW4	GROUNDWATER	Benzene	0.1750
PC-P1	MW6	PC-P1-MW6-GW4	GROUNDWATER	Benzene	10.0000
PC-P1	MW1	PC-P1-MW1-GW4	GROUNDWATER	Bromodichloromethane	0.2000
PC-P1	MW11	PC-P1-MW11-GW4	GROUNDWATER	Bromodichloromethane	0.2000
PC-P1	MW12	PC-P1-MW12-GW4	GROUNDWATER	Bromodichloromethane	0.2000
PC-P1	MW13	PC-P1-MW13-GW4	GROUNDWATER	Bromodichloromethane	0.2000
PC-P1	MW14	PC-P1-MW14-GW4	GROUNDWATER	Bromodichloromethane	0.7800
PC-P1	MW2	PC-P1-MW2-GW4	GROUNDWATER	Bromodichloromethane	0.2000
PC-P1	MW3	PC-P1-MW3-GW4	GROUNDWATER	Bromodichloromethane	0.2000
PC-P1	MW4	PC-P1-MW4-GW4	GROUNDWATER	Bromodichloromethane	0.2000
PC-P1	MW6	PC-P1-MW6-GW4	GROUNDWATER	Bromodichloromethane	0.2000
PC-P1	MW1	PC-P1-MW1-GW4	GROUNDWATER	Dibenzofuran	2.5000
PC.P1	11/1/11	PC-P1-MW/11-GW/4	GROUNDWATER	Dibenzofuran	2.5000

Table P-1A (continued)

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Groundwater - Site 1

MIANG, Alpena CRTC, Alpena, MI

SITE	LOCATOR	SAMPLEID	MATRIX	ANALYTE	RESULT
PC-P1	MW12	PC-P1-MW12-GW4	GROUNDWATER	Dibenzofuran	2.5000
PC-P1	MW13	PC-P1-MW13-GW4	GROUNDWATER	Dibenzofuran	2.5000
PC-P1	MW14	PC-P1-MW14-GW4	GROUNDWATER	Dibenzofuran	2.5000
PC-P1	MW2	PC-P1-MW2-GW4	GROUNDWATER	Dibenzofuran	2.5000
PC-P1	MW3	PC-P1-MW3-GW4	GROUNDWATER	Dibenzofuran	2.5000
PC-P1	MW4	PC-P1-MW4-GW4	GROUNDWATER	Dibenzofuran	2.5000
PC-P1	MW6	PC-P1-MW6-GW4	GROUNDWATER	Dibenzofuran	1.0000
PC-P1	MW1	PC-P1-MW1-GW4	GROUNDWATER	Dibromochloromethane	0.1500
PC-P1	MW11	PC-P1-MW11-GW4	GROUNDWATER	Dibromochloromethane	0.1500
PC-P1	MW12	PC-P1-MW12-GW4	GROUNDWATER	Dibromochloromethane	0.1500
PC-P1	MW13	PC-P1-MW13-GW4	GROUNDWATER	Dibromochloromethane	0.1500
PC-P1	MW14	PC-P1-MW14-GW4	GROUNDWATER	Dibromochloromethane	2.1000
PC-P1	MW2	PC-P1-MW2-GW4	GROUNDWATER	Dibromochloromethane	0.1500
PC-P1	MW3	PC-P1-MW3-GW4	GROUNDWATER	Dibromochloromethane	0.1500
PC-P1	MW4	PC-P1-MW4-GW4	GROUNDWATER	Dibromochloromethane	0.1500
PC-P1	MW6	PC-P1-MW6-GW4	GROUNDWATER	Dibromochloromethane	0.1500
PC-P1	MW1	PC-P1-MW1-GW4	GROUNDWATER	Styrene	0.1250
PC-P1	MW11	PC-P1-MW11-GW4	GROUNDWATER	Styrene	0.1250
PC-P1	MW12	PC-P1-MW12-GW4	GROUNDWATER	Styrene	0.1250
PC-P1	MW13	PC-P1-MW13-GW4	GROUNDWATER	Styrene	0.1250
PC-P1	MW14	PC-P1-MW14-GW4	GROUNDWATER	Styrene	0.1250
PC-P1	MW2	PC-P1-MW2-GW4	GROUNDWATER	Styrene	0.1250
PC-P1	MW3	PC-P1-MW3-GW4	GROUNDWATER	Styrene	0.1250
PC-P1	MW4	PC-P1-MW4-GW4	GROUNDWATER	Styrene	0.1250
PC-P1	MW6	PC-P1-MW6-GW4	GROUNDWATER	Styrene	8.5000
PC-PW	PW1	PC-PW-PW1-GW4	GROUNDWATER	Carbon Tetrachloride	0.1750
PC-PW	PW2	PC-PW-PW2-GW4	GROUNDWATER	Carbon Tetrachloride	0.1750
PC-PW	PW3	PC-PW-PW3-GW4	GROUNDWATER	Carbon Tetrachloride	1.2000

Table P-2A

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Sediment - Site 1

MIANG, Alpena CRTC, Alpena, MI

SITE	LOCATOR	SAMPLE ID	MATRIX	ANALYTE	SAMPLE DEPTH RANGE	тн	RESULT
PC-P1	SD001	PC-P1-SD001	SEDIMENT	Arsenic	0.0000	0.0000	3.0000
PC-P1	SD002	PC-P1-SD002	SEDIMENT	Arsenic	0.0000	0.000	5.8000
PC-P1	SD003	PC-P1-SD003	SEDIMENT	Arsenic	00000	0.000	0.9600
PC-P1	SD005	PC-P1-SD005	SEDIMENT	Arsenic	0.0000	0.000	3.4000
PC-P1	SD001	PC-P1-SD001	SEDIMENT	Copper	00000	0.000.0	2.3000
PC-P1	SD002	PC-P1-SD002	SEDIMENT	Copper	0.0000	0.000	5.3000
PC-P1	SD003	PC-P1-SD003	SEDIMENT	Copper	0.0000	0.000	0.9500
PC-P1	SD005	PC-P1-SD005	SEDIMENT	Copper	0.0000	0.0000	24.0000

Table P-3A

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Subsolls - Site 1

MIANG, Alpena CRTC, Alpena, MI

SITE	LOCATOR	SAMPLE ID	MATRIX	ANALYTE	SAMPLE DEPTH RANGE		RESULT
PC-P1	SB01	PC-P1-SB01	SUBSOIL	Chlorobenzene	0.0000	0.000	2.1000
PC-P1	SB01	PC-P1-SB01	SUBSOIL	Chlorobenzene	Ü	0000.0	6200.0000
PC-P1	SB02	PC-P1-SB02	SUBSOIL	Chlorobenzene	0.0000	0000.0	1.9000
PC-P1	SB02	PC-P1-SB02	SUBSOIL	Chlorobenzene	_	0000.0	0.3100
PC-P1	SB03	PC-P1-SB03	SUBSOIL	Chlorobenzene	0.0000	0000.0	2.0000
PC-P1	SB03	PC-P1-SB03	SUBSOIL	Chlorobenzene	0.0000	0000.0	1.9000
PC-P1	SB01	PC-P1-SB01	SUBSOIL	Ethylbenzene	0.0000	0000.0	0.2000
PC-P1	SB01	PC-P1-SB01	SUBSOIL	Ethylbenzene	0.0000	0000.0	7900.0000
PC-P1	SB02	PC-P1-SB02	SUBSOIL	Ethylbenzene	0.0000	0000.0	1.9000
PC-P1	SB02	PC-P1-SB02	SUBSOIL	Ethylbenzene	0.0000	0000.0	0.1400
PC-P1	SB03	PC-P1-SB03	SUBSOIL	Ethylbenzene	_	0000.0	2.0000
PC-P1	SB03	PC-P1-SB03	SUBSOIL	Ethylbenzene	0.0000	0000.0	1.9000
PC-P1	SB01	PC-P1-SB01	SUBSOIL	Styrene	0.0000	0000.0	1.8000
PC-P1	SB01	PC-P1-SB01	SUBSOIL	Styrene	0.0000	0000.0	7800.0000
PC-P1	SB02	PC-P1-SB02	SUBSOIL	Styrene	0.0000	0000.0	1.6000
PC-P1	SB02	PC-P1-SB02	SUBSOIL	Styrene	0.0000	0000.0	0.6600
PC-P1	SB03	PC-P1-SB03	SUBSOIL	Styrene	0.0000	0000.0	1.7000
PC-P1	SB03	PC-P1-SB03	SUBSOIL	Styrene	0.0000	0000.0	1.6000

TABLE P-1 EXPOSURE ASSESSMENT PARAMETERS - INGESTION OF GROUNDWATER Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

ADULI	
	ב ב ב
2	2
298 *	48
25	ე ე
9	/7
ç	ç
0, 6	2 4
c,	2
70 25	

*Worst case scenario assumes the facility employee and recreational adult are the same person. The facility employee is on-site 250 days/year as an employee and uses the recreational facilities an additional 48 days/year for a total exposure frequency of 298 days/year.

TABLE P-2 DAILY INTAKE - ADULT INGESTION OF SHALLOW AQUIFER PRODUCTION WELL GROUNDWATER FUTURE LAND USE SCENARIO

	Limod	10000			2	A	1
	CITETING	Hollseafilli	Exposure	Exposite	pody	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Duration	Weight	Time	Rate
	(mg/l)	(L/day)	(days/year)	(years)	(kg)	(days)	(mg/Kg-day)
Benzene	2.700E-04	2	298	25	70	9125	6.298E-06
Antimony, Dissolved	1.400E-03	2	298	25	2	9125	3.266E-05
Bromodichloromethane	9.000E-06	2	298	25	2	9125	2.099E-07
Dibromochloromethane	2.600E-05	2	298	25	2	9125	6.065E-07
Dibenzofuran	5.000E-06	2	298	25	2	9125	1.166E-07
1,4-Dichlorobenzene	1.500E-06	2	298	25	2	9125	3.499E-08
Styrene	2.600E-06	2	298	25	2	9125	6.065E-08
Carbon Tetrachloride	1.200E-03	2	298	25	02	9125	2.799E-05

TABLE P-3 DAILY INTAKE - CHILD
INGESTION OF SHALLOW AQUIFER GROUNDWATER
FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

	Chemical	Ingestion		Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Duration	Weight	Time	Rate
	(mg/kg)	(L/day)	ت	(years)	(kg)	(days)	(mg/Kg-day)
Benzene	2.700E-04	2.000	48	15	27	5475	2.630E-06
Antimony, Dissolved	1.400E-03	2.000	48	15	27	5475	1.364E-05
Bromodichloromethane	9.000E-06	2.000	48	15	27	5475	8.767E-08
Dibromochloromethane	2.600E-05	2.000	48	15	27	5475	2.533E-07
Dibenzofuran	5.000E-06	2.000	48	15	27	5475	4.871E-08
1,4-Dichlorobenzene	1.500E-06	2.000	48	15	27	5475	1.461E-08
Styrene	2.600E-06	2.000	48	15	27	5475	2.533E-08
Carbon Tetrachloride	1.200E-03	2.000	48	15	27	5475	1.169E-05
				The second secon			

TABLE P-4 DAILY INTAKE - ADULT
INGESTION OF SHALLOW AQUIFER GROUNDWATER
FUTURE LAND USE SCENARIO

		1		Exposite	Body	Averaging	Intake
	Chemical	uonsabui	Exposure	3	18/-:	Limo	Pate
	Concentration	Rate	Frequency	Duration	vveignt	9111	- Caro
Chemical		(Velay)	(days/year)	(vears)	(kg)	(days)	(mg/Kg-day)
	(mgn)	(Encla)	000	30	70	25550	2.249E-06
Renzene	2.700E-04	7	230	3 6	9.6	25550	1 166E.05
	1 AOOE-03	2	298	62	2	23330	1.1001.0
Antimony, Dissolved	00 H000 0	C	298	25	2	25550	7.498E-08
Bromodichloromethane	S.UUUE-US	4 (000	3,0	20	25550	2.166E-07
Dibromochloromethane	2.600E-05	7	730	24	2 6	2000	4 4665 08
	S DODE-DE	2	298	25	2	75550	4. IOOE-00
Dibenzofuran	0.0000.0	ור	8000	35	02	25550	1.250E-08
1.4-Dichlorobenzene	1.5001-06	71	007	3 1	2 6	25550	2 166F-08
	2 600E-06	2	282	67	2	20007	
Signature	1 2005 03	0	298	25	2	25550	9.99/E-06
Carbon Tetrachloride	1.200E-03	-					

TABLE P-6 DAILY INTAKE - CHILD
INGESTION OF SHALLOW AQUIFER GROUNDWATER
FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 1. Former POL Facility, Alpena CRTC, Alpena, MI

Site 1, Former POL Facility, Alberta CR1C, Alberta, IVII	Alpena CRIC, Alpena, IVII						
Chemical	Chemical Concentration	Ingestion Rate (L/dav)	Exposure Frequency (davs/vear)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Intake Rate (mg/Kg-day)
Benzene Antimony, Dissolved Bromodichloromethane Dibromochloromethane Diberzofuran 1,4-Dichlorobenzene Sakyrene Carbon Tetrachloride	2.700E-04 1.400E-03 9.000E-05 2.600E-05 5.000E-06 1.500E-06 1.200E-06	2.000 2.000 2.000 2.000 2.000 2.000 2.000	1 1	2	22 22 23 24 24 24 24 24 24 24 24 24 24 24 24 24	25550 25550 25550 25550 25550 25550 25550 25550 25550	5,636E-07 2,922E-06 1,879E-08 5,427E-08 1,044E-08 3,131E-09 5,427E-09 2,505E-06

TABLE P-6 EXPOSURE ASSESSMENT PARAMETERS - INHALATION OF GROUNDWATER Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

Parameter	ADULT	CHILD
Exposure Time (hours/day)	0.12	0.12
Inhalation Rate (cu m/hr)	0.6	9.0
Exposure Frequency (days/yr)	298	48
Exposure Duration (years)	25	15
Body Weight, Kg	70	27
Averaging Time		
Carcinogens	02	70
Noncarcinogens	25	15

TABLE P-7 DAILY INTAKE - ADULT INHALATION OF SHALLOW AQUIFER GROUNDWATER FUTURE LAND USE SCENARIO

		100	2000	- Carloo	Lynonia	a de	Averaging	
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(ma/cn m)	(cn m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	
Bonzone	2 550E-03	9.0	298	0.12	25	70	9125	
Antimony Dissolved		9.0	298	0.12	25	20	9125	
romodichloromethane	8 501E-05	9.0	298	0.12	25	20	9125	7.139E-08
Districtionsofts	2 456F-04	9.0	298	0.12	25	20	9125	
Dibonzofuran	i	9.0	298	0.12	25	2	9125	
A Dichlorobonzono	1 417F-05	9.0	298	0.12	22	2	9125	
4-Diction of the first the	2.456E-05	9.0	298	0.12	25	02	9125	
Carbon Tetrachloride	1.134E-02	9.0	298	0.12	25	20	9125	

TABLE P-8 DAILY INTAKE - CHILD INHALATION OF SHALLOW AQUIFER GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 1, Former POL Facility, Alpena CRTC, Alpena MI

	Chemical	Inhalation	Exposure	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(ma/cn m)	(cn m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	(mg/Kg-day)
Ronzono	2.550E-03	9.0	48	0.12	15	27	5475	8.944E-07
Antimony Dissolved		9.0	48	0.12	15	27	5475	0.000E+00
Bromodichloromethane	8.501E-05	9:0	48	0.12	15	27	5475	2.981E-08
Dibromorhloromethane	2.456E-04	9.0	48	0.12	5	27	5475	8.613E-08
Dibenzofitran	i	9.0	48	0.12	51	27	5475	0.000E+00
1 4 Dichlorohenzene	1.417E-05	9.0	48	0.12	15	27	5475	4.969E-09
Styrene	2.456E-05	9.0	48	0.12	15	27	5475	8.613E-09
Carbon Tetrachloride	1.134E-02	9.0	48	0.12	15	27	5475	3.975E-06

TABLE P-9 DAILY INTAKE - ADULT INHALATION OF SHALLOW AQUIFER GROUNDWATER FUTURE LAND USE SCENARIO

	Chemical	Inhalation	Exposure	Exposure	Exposure	Body	Averaging	intake
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(mg/cn m)	(ca m/hr)	(days/year)	ᅩ		(kg)	(days)	(mg/Kg-day)
Вепzепе	2.550E-03	9.0	298	0.12	25	70	25550	7.649E-07
Antimony, Dissolved		9.0	298		25	70	25550	0.000E+00
Bromodichloromethane	8.501E-05	9.0	298		25	20	25550	2.550E-08
Dibromochloromethane	2.456E-04	9.0	298			02	25550	7.366E-08
Dibenzofuran		9.0	298			20	25550	0.000E+00
1,4-Dichlorobenzene	1.417E-05	9.0	298		25	20	25550	4.250E-09
Styrene	2.456E-05	9.0	298			70	25550	7.366E-09
Carbon Tetrachloride	1.134E-02	9.0	298			20	25550	3.400E-06

TABLE P-10 DAILY INTAKE - CHILD INHALATION OF SHALLOW AQUIFER GROUNDWATER FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment
Site 1, Former POL Facility, Alpena CRTC, Alpena MI

Averaging Time (days) 25550 25550 25550 25550 25550 25550 25550 25550 25550 25550 25550 Body Weight (kg) 27 27 27 27 27 27 27 27 27 (years) £ £ £ £ £ £ £ £ Duration Exposure Exposure (hours/day) Frequency (days/year) Exposure Rate 0.6 0.6 0.6 0.6 0.6 0.6 Inhalation (cn m/hr) 1.417E-05 2.456E-05 1.134E-02 8.501E-05 2.456E-04 (mg/cu m) 2.550E-03 Chemical Concentration Dibromochloromethane Bromodichloromethane 1,4-Dichlorobenzene Carbon Tetrachloride Antimony, Dissolved Dibenzofuran Chemical Benzene Styrene

(mg/kg-day) 1.917E-07 0.000E+00 6.389E-09 1.846E-08 0.000E+00 1.065E-09 8.518E-07

Intake Rate

TABLE P-11 GROUNDWATER INHALATION MODEL CALCULATIONS Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

							S S S S S S S S S S S S S S S S S S S	
				Showering Pos	Post Showering		Maximum	Showering MAX
Chemicals	Chemical	Fraction Volatilized	Water Flow Rate		Duration Period	Bathroom	Contaminant Concn'n in Air	Concarinant Concarin in Air
	(mg/L)	(unitless)	(L/hr)	(hr)	(hr)	(cu m)	3.222E-03	2.550E-03
Benzene Antimony, Dissolved Bromodichloromethane Dibromochloromethane Dibenzofuran 1,4-Dichlorobenzene Styrene	2.700E-04 1.400E-03 9.000E-06 2.600E-05 5.000E-06 1.500E-06 1.200E-06	7.0 7.0 7.0 7.0 7.0 7.0 7.0	750 750 750 750 750 750 750	0.25 0.25 0.25 0.25 0.25 0.25	0.35 0.35 0.35 0.35 0.35	=======================================	1.670E-02 1.074E-04 3.102E-04 5.966E-05 1.790E-05 3.102E-05 1.432E-02	1,322E-02 8,501E-05 2,456E-04 4,723E-05 1,417E-05 2,456E-05 1,134E-02

TABLE P-12 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH GROUNDWATER Site 1, Former POL Facilty, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	CHILD	
Skin Surface Area Available for Contact (sq cm)	19400	13300	
Exposure Time (hrs/day)	0.25	0.25	
Dermal Permeability Constant *	0.00084	0.00084	
Exposure Frequency (days/year)	298	48	
Exposure Duration (years)	25	15	
Body Weight, Kg	20	27	
Averaging Time			
Carcinogens	70	02	
Noncarcinogens	25	15	
Conversion Factor	0.001		
			_

P-13 DAILY INTAKE - ADULT GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

	Chemical	Dermal	Skin	Exposure	ш	Exposure	Body	Averaging	Conversion	Intake
	Concentration	Dermeshility	Surface Area	Frequency		Duration	Weight	TIMe	Factor	Kate
	Concentration (may)	(cm/hr)	(ma pa)	(days/vear)	(hrs/dav)	(vears)	(kg)	(days)	(I/cn cm)	(mg/Kg-day)
	(ingin)		10400	29.8		25	20	9125	0.001	1.527E-06
(E)	Z. / UUE-U4	. 60	19400	800		35	20	9125	0.001	7.919E-08
<u>ပ</u>	1.400E-03	100.0	19400	007		3 6		2010	1000	2 9535-09
(4)	9 000E-06	0.0058	19400	298		52	0	6716	00.0	
3	2 600 0		19400	298		52	70	9125	0.001	5.736E-09
(a)	Z.SOUE-O3			0 0		ď	20	9125	0 001	2.376E-10
	5.000E-06	0.00084	19400	290		77	2			1
177	90 11003 7	Can o	19400	298		25	2	9125	0.001	5.201E-09
<u>a</u>	300E-08	200.0	000	000		30	70	9125	0.001	1.235E-10
	2.600E-06	0.00084	19400	067		3				4 4021 06
	1 200F-03	0.022	19400	298		52	2	9125	0.001	1.49311-05

(a) Experimentally measured PC (Table 5-3 of U. S. EPA, 1992a).
 (b) Predicted PC (Table 5-7 of U.S. EPA, 1992a).
 (c) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC valuew (Table 5-3 of U. S. EPA, 1992a).

P-14 DAILY INTAKE - CHILD GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Noncarcinogenic Effect Exposure Assessment

Site 1, Former POL Facility	Site 1, Former POL Facility, Alpena CRIC, Alpena Mi									
Chemical	Chemical Concentration	Dermal Permeability (cm/hr)	Surfa	Exposure Frequency (days/year)	Exposure Time (hrs/day)	Exposi Dura (ye	Body Weight (kg)	Averaging Time (days)	Conversion Factor (Vcu cm)	Intake Rate (mg/Kg-day)
Benzene Antimony, Dissolved Bromodichloromethane Dibenzochiromethane 1,4-Dichlorobenzene Styrene Carbon Tetrachloride	(a) 2.700E-04 (c) 1.400E-03 (b) 2.600E-05 (b) 2.600E-05 (b) 1.500E-06 1.500E-06 1.200E-06	0.1 0.001 0.0058 0.0039 0.00084 0.0084 0.0084	13300 13300 13300 13300 13300 13300 13300	4 4 8 8 4 4 8 8 4 4 8 8 4 4 8 8 4 4 8 8 4 4 8 8 8 4 8 8 8 4 8	0.25 0.25 0.25 0.25 0.25 0.25 0.25	25 25 25 25 25 25 25 25 25 25 25 25 25 2	44444444	5475 5475 5475 5475 5475 5475 5475	0.001 0.001 0.001 0.001 0.001 0.001	4.3/3E-0/ 2.267E-08 8.454E-10 1.642E-09 6.802E-11 1.506E-10 3.537E-17 4.275E-07

(a) Experimentally measured PC (Table 5-3 of U. S. EPA, 1992a).
(b) Predicted PC (Table 5-7 of U.S. EPA, 1992a).
(c) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC valuew (Table 5-3 of U. S. EPA, 1992a).

P-15 DAILY INTAKE - ADULT GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Chemical Concentration Permeability Surface Area Frequency Time Duration Weight Benzene (a) 2.700E-04 0.1 19400 298 0.25 25 70 Antimony, Dissolved (c) 1.400E-03 0.001 19400 298 0.25 25 70 Bromodichloromethane (b) 2.600E-05 0.0039 19400 298 0.25 25 70 Dibenzofuran 5.00E-06 0.0039 19400 298 0.25 25 70 Styrence of construction of constru			Chemical	Dermal	Exposure	Exposure	ш	Body	Averaging	Conversion	Intake
(mg/l) (mg/l) (cm/hr) (sq cm) (days/veat) (hrs/day) (years) (years) y, Dissolved (c) 1,400E-03 0.1 19400 298 0.25 25 y, Dissolved (c) 1,400E-03 0.001 19400 298 0.25 25 chloromethane (b) 2,600E-05 0.0039 19400 298 0.25 25 furan 5,000E-06 0.00084 19400 298 0.25 25 furan 1,500E-06 0.00084 19400 298 0.25 25 furan 2,600E-06 0.00084 19400 298 0.25 25 fetrachloride 1,500E-06 0.00084 19400 298 0.25 25 fetrachloride 1,200E-03 0,0022 19400 298 0.25 25	Chemical		Concentration	Permeability	 Frequency	Time		Weight	Time	Factor	Rate
(a) 2.700E-04 0.1 19400 298 0.25 25 25 25 25 25 25 25 25 25 25 25 25 2			(mg/l)	(cm/hr)	(days/year)	(hrs/day)		(kg)	(days)	(Vcu cm)	(mg/Kg-day)
y, Dissolved (c) 1.400E-03 0.001 19400 298 0.25 25 ichloromethane (b) 9.000E-06 0.0058 19400 298 0.25 25 cohloromethane (b) 2.600E-05 0.0039 19400 298 0.25 25 furan 5.000E-06 0.00084 19400 298 0.25 25 lorobenzene (b) 1.500E-06 0.0062 19400 298 0.25 25 Zeone-06 0.00084 19400 298 0.25 25 Testachloride 1.200E-03 0.022 19400 298 0.25 25	Benzene	(a)	2.700E-04	0.1	298	0.25		02	25550	0.001	5.455E-07
ichloromethane (b) 9.000E-06 0.0058 19400 298 0.25 25 25 25 25 25 25 25 25 25 25 25 25 2	Antimony, Dissolved	(၁)	1.400E-03	0.001	298	0.25		20	25550	0.001	2.828E-08
rchloromethane (b) 2.600E-05 0.0039 19400 298 0.25 25 furan 5.000E-06 0.00084 19400 298 0.25 25 lorobenzene (b) 1.500E-06 0.062 19400 298 0.25 25 Zebone-0-06 0.00084 19400 298 0.25 25 Tetrachloride 1.200E-03 0.022 19400 298 0.25 25	Bromodichloromethane	(q)	9.000E-06	0.0058	298	0.25		20	25550	0.001	1.055E-09
furan 5.000E-06 0.00084 19400 298 0.25 25 [100benzene (b) 1.500E-06 0.062 19400 298 0.25 25 [25 25 25] [25 25 25 25] [25 25 25 25] [25 25 25] [25 25 25] [25 25 25] [25 25 25] [25 25 25] [25	Dibromochloromethane	(p)	2.600E-05	0.0039	298	0.25		20	25550	0.001	2.049E-09
lorobenzene (b) 1.500E-06 0.062 19400 298 0.25 25 2.600E-06 0.00084 19400 298 0.25 25 Tetrachloride 1.200E-03 0.022 19400 298 0.25 25	Dibenzofuran		5.000E-06	0.00084	298	0.25		02	25550	0.001	8.485E-11
2.600E-06 0.00084 19400 298 0.25 25 Tetrachloride 1.200E-03 0.022 19400 298 0.25 25	1,4-Dichlorobenzene	(p)	1.500E-06	0.062	298	0.25		02	25550	0.001	1.879E-09
1,200E-03 0 022 19400 298 0 25 25	Styrene		2.600E-06	0.00084	298	0.25		02	25550	0.001	4.412E-11
	Carbon Tetrachloride		1.200E-03	0.022	298	0.25		20	25550	0.001	5.334E-07

(a) Experimentally measured PC (Table 5-3 of U. S. EPA, 1992a).
 (b) Predicted PC (Table 5-7 of U.S. EPA, 1992a).
 (c) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC valuew (Table 5-3 of U. S. EPA, 1992a).

P-16 DAILY INTAKE - CHILD GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 1, Former POL Facility, Alpena CRTC, Alpena Mi

		Chemical	Dermal	Skin	Exposure	Exposure	Exposure	Body	Averaging	Conversion	Intake
Chemical		Concentration (mg/l)	Permeability (cm/hr)	Surface Area	Frequency	Time (hra/day)	Duration (vears)	Weight	Time (deve)	Factor	Rate
Benzene (8	(8)	2.700E-04	0.1	13300	48	0.25	15	27	25550	0.001	9.370E-08
Antimony, Dissolved (c	(0)	1.400E-03	0.001	13300	48	0.25	15	27	25550	0.001	4.858E-09
Bromodichioromethane (1	(q)	9.000E-06	0.0058	13300	48	0.25	15	27	25550	0.001	1.812E-10
Dibromochloromethane (1	(p)	2.600E-05	0.0039	13300	48	0.25	15	27	25550	0.001	3.519E-10
Dibenzofuran		5.000E-06	0.00084	13300	48	0.25	15	27	25550	0.001	1.458E-11
1,4-Dichlorobenzene (I	(1.500E-06	0.062	13300	48	0.25	15	27	25550	0.001	3.227E-10
Styrene		2.600E-06	0.00084	13300	48	0.25	15	27	25550	0.001	7.579E-12
Carbon Tetrachloride		1.200E-03	0.022	13300	48	0.25	15	27	25550	0.001	9.162E-08

(a) Experimentally measured PC (Table 5-3 of U. S. EPA, 1992a).
(b) Predicted PC (Table 5-7 of U.S. EPA, 1992a).
(c) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC valuew (Table 5-3 of U. S. EPA, 1992a).

TABLE P-17 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH SOILS SHe 1, Former POL Facility, Alpena CRTC, Alpena, MI

	EXCAVATION
PARAMETER	WORKER
10000	3120
Skin Surface Area Available for Contact (cm².∠/day) Soll to Skin Adherence Factor (mg/cm².2)	2.77
Absorption Factor, Unitless	0.01
Metals	0.25
Organics	250
Exposure Factor (days/year)	800
Exposure Duration (year)	02
Body Weight (kilograms)	90-4
Conversion Factor	80.0
Averaging Time, vears	

STEID WEI SADIZ?

TABLE P-18 DAILY INTAKE - ADULT
DERMAL CONTACT WITH SOILS
FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

	Chemical	Conversion	Available	Soll to	Absorption	Exposure	Exposure	Body	Average	Absorbed
Chemical	Concentration	Factor	Skin Surface	Skh Adherence	Factor	Frequency	Duratton	Weight	Time	Dose
	(mg/kg)	(kg/mg)	(cm^2/day)	(mg/cm ⁴ 2)	(anittess)	(days/year)	(years)	(kg)	(days)	(mg/kg-day)
Chlorobenzene	3,116E+00	1.00E-06	3120	2.77	0.25	250	0.08	20	29.2	6.588E-05
Ethylbenzene	3.970E+00	1.00E-06	3120	2.77	0.25	250	0.08	70	29.2	8.394E-05
Styrene	3.920E+00	1.00E-06	3120	2.77	0.25	250	0.08	20	29.2	8.288E-05

TABLE P-19 DAILY INTAKE - ADULT
DERMAL CONTACT WITH SOILS
FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

Carcinogenic Effect Exposure Assessment Site 1, Former POL Facility, Alpena CRTC, Alpena Mi

		0000		Soll to			Exposure	Body	Average	Absorbed
	Concentration	Factor	Sidn Surface	Skin Adherence	Factor	Frequency	Duration	Weight	TIME	Dose
Chemical	(mg/kg)	(ka/ma)		(mg/cm^2)		_	(years)	(kg)	(days)	(mg/kg-day)
	3 1465-100	1 05-08	1	2.77			0.08	70	25550	7.529E-08
Chloropenzene	3,110110	20 110:1		74.0			0.08	02	25550	9.593E-08
Ethylbenzene	3.970E+00	1.0E-08		11.7		000	0.0		28580	0 4725.08
Styrene	3.920E+00	1.0E-06		2.11			0.00	2	2000	0.4144.00

TABLE P-20 EXPOSURE ASSESSMENT PARAMETERS - SOIL INDESTION Sits 1, Former POL Facility, Alpena CRTC, Alpena, MI

PARAMETER	EXCAVATION WORKER
Ingestion Rate (mg/day)	480
Fraction Ingested from	
Contaminated Sources (unitless)	-
Exposure Frequency (days/year)	250
Exposure Duration (years)	0.08
Body Weight (kilograms)	70
Conversion Factor	1E-06
Averaging Time	
Carcinogenic	70
Noncarcinogenic	0.08

TABLE P-21 DAILY INTAKE - ADULT SOIL INGESTION FOUR FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

Site 1, Former POL	Site 1, Former POL Facility, Alpena CRTC, Alpena, MI								Constant
	- Cimed	Conversion	Excavation Worker	Fraction	Exposure	Exposure	Body	Average	Worker
	in the state of th	Rate		Indested	Frequency	Duration	Weight	Time	Intake Rate
Chemical	(24)(24)			(unitless)	(days/year)	(years)	(kg)	(days)	(mg/kg-day
	3 1165-103	15.06	ļ		250	0.08	70	29.2	1.464E-02
hiorobenzene	50+1050 6	11.06		. 4	250	0.08	70	29.2	1.865E-02
Ethylbenzene	50+B0/8/6	16-06	480	_	250	0.08	70	29.2	1.841E-0

TABLE P-22 DAILY INTAKE - ADULT SOIL INGESTION FUTURE LAND USE SCENARIO - EXCAVATION AND PLANT EMPLOYEES

Carcinogenic Effect Site 1, Former POL	Carcinogenic Effect Exposure Assessment Site 1, Former POL, Facility, Alpena CRTC, Alpena, Mi								
			Excavation						Excavation
	Chemical	Conversion		Fraction	Exposure	Exposure	Body	Average	Worker
Chemical	Concentration	Rate	Ingestion Rate	Ingested	Frequency	Duration	Weight	Time	intake Rate
	(mg/kg)		(mg/day)	(unitless)	(days/year)	(years)	(kg)	(days)	(mg/kg-day)
Chlorobenzene	3.116E+03	1E-06	480	-	250	0.08	70	25550	1.673E-05
Ethylbenzene	3.970E+03	16-06	480	-	250	0.08	70	25550	2.131E-05
Styrene	3.920E+03	1E-06	480	-	250	0.08	70	25550	2.104E-05

TABLE P-23 EXPOSURE ASSESSMENT PARAMETERS - FISH INGESTION Site 1, Former POL Facility, Alpena CRTC, Alpena, Mi

PARAMETER	ADULT	CHILD
Eraction of Fish Indested unitless	0.5	0.5
Innestion rate kg/day	0.054	0.043
Franchine Frequency days/vr	26	56
Exposure Duration (vers)	25	15
Body Weight, Kg	20	27
Averaging Time	Ç	Ş
Carcinogens	0 %	Q 4
Noncarcinogens	67	2

TABLE P-24 DAILY INTAKE-ADULT FISH INGESTION FUTURE LAND USE SCENARIO

Chemical	Chemical Concentration	Ingestion Rate	Exposure Frequency	Fraction Ingested	Exposure Duration	Body Weight	Averaging Time	Intake Rate
	(mg/kg)	(kg/day)	(days/year)	(unitless)	(years)	(kg)	(days)	(mg/Kg-day)
Benzene	3.840E-03	0.054	56	0.5	25	70	9125	1.055E-07
Antimony, Dissolved	9.000E-06	0.054	56	0.5	25	2	9125	2.473E-10
Bromodichloromethane	6.900E-04	0.054	26	0.5	25	02	9125	1.896E-08
Dibromochloromethane	3.450E-05	0.054	26	0.5	25	70	9125	9.479E-10
Dibenzofuran	5.000E-06	0.054	26	0.5	25	70	9125	1.374E-10
1,4-Dichlorobenzene	1.200E-04	0.054	26	0.5	25	20	9125	3.297E-09
Styrene	6.500E-01	0.054	56	0.5	25	20	9125	1.786E-05
Carbon Tetrachloride	1.000E-05	0.054	26	0.5	52	20	9125	2.748E-10

TABLE P-26 DAILY INTAKE - CHILD FISH INGESTION FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 1, Former POL Facility, Alpena CRTC, Alpena MI

Chemical	Chemical Concentration	Ingestion Rate	Exposure Frequency	Fraction	Exposure Duration	Body Weight	Averaging Time	
	(mg/kg)	(kg/day)	(days/year)	(unitless)	(years)	(kg)	(days)	(mg/Kg-day)
Benzene	3.840E-03	0.043	26	0.5	15	27	5475	2.178E-07
Antimony, Dissolved	9.000E-06	0.043	56	0.5	15	27	5475	5.105E-10
Bromodichloromethane	6.900E-04	0.043	56	0.5	15	27	5475	3.914E-08
Dibromochloromethane	3.450E-05	0.043	58	0.5	15	27	5475	1.957E-09
Dibenzofuran	5.000E-06	0.043	56	0.5	15	27	5475	2.836E-10
1,4-Dichlorobenzene	1.200E-04	0.043	56	0.5	15	27	5475	6,807E-09
Styrene	6.500E-01	0.043	56	0.5	15	27	5475	3.687E-05
Carbon Tetrachloride	1.000E-05	0.043	56	0.5	5	27	5475	5.672E-10

TABLE P-26 DAILY INTAKE - ADULT FISH INGESTION FUTURE LAND USE SCENARIO

Chemical	Chemical Concentration (mg/kg)	Ingestion Rate (kg/day)	Exposure Frequency (days/year)	Fraction Ingested (unitless)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Intake Rate (mg/Kg-day)
Benzene Antimony, Dissolved Bromodichloromethane Dibromochloromethane 1,4-Dichlorobenzene Styrene Carbon Tetrachloride	3.840E-03 9.000E-06 6.900E-04 3.450E-05 5.000E-06 1.200E-04 6.500E-01 1.000E-05	0.054 0.054 0.054 0.054 0.054 0.054	888888888	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	* * * * * * * * *	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	25550 25550 25550 25550 25550 25550 25550 25550 25550	3.768E-08 8.831E-11 6.771E-09 3.385E-10 4.906E-11 1.178E-09 6.378E-06

TABLE P-27 DAILY INTAKE - CHILD FISH INGESTION FUTURE LAND USE SCENARIO Carcinogenic Effect Exposure Assessment Site 1. Former POL Facility, Alpena CRTC, Alpena MI

Chemical Concentration Chemical Concentration Rate Frequency Imgestion Practicular Concentration Property Concentra			4		n citation	Cynoeiro	Body	Averaging	_
(mg/kg) (kg/day) (days/year) (unitless) (years) (kg) (days) (mg/kg) (mg/kg) (days) (mg/kg) (Concentration	Ingestion	Frequency	Ingested	Duration	Weight	Time	Rate
3.840E-03	Chemical	(ma/ka)	(kg/day)	(days/year)	(unitless)	(years)	(kg)	(days)	(mg/Kg-day)
3840E-03 0.043 26 0.5 15 27 2550 4 2000E-06 0.043 26 0.5 15 27 2550 4 2000E-06 0.043 26 0.5 15 27 2550 1 2 2550 1 2 2550 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		(8.8							
9,000E-06 0,043 26 0,05 16 0,043 26 0,05 15 27 25550 19 3,450E-05 0,043 26 0,05 15 27 25550 15 27 25550 17 25550 18 27 25550 17 25550 18 27 25550 19 27 25550 19 27 25550 19 27 25550 19 27 25550 19 27 25550 19 27 25550 19 27 25550 19 27 25550 19 27 25550 19 27 25550 19 27 25550 19 27 25550 19 27 25550	í	3 BADE 03	0.043	98	0.5	5	27	25550	4.667E-08
Te 6.900E-04 0.043 26 0.5 15 27 2550 8 0.5 15 27 2550 8 0.5 15 27 2550 8 0.5 15 27 2550 8 0.043 26 0.5 15 27 2550 4 0.043 26 0.5 15 27 2550 4 0.043 26 0.5 15 27 2550 6 0.5 15 27 2550 6 0.5 15 27 2550 6 0.043 26 0.5 15 27 2550 6 0.043 26 0.5 15 27 2550 6 0.043 26 0.5 15 27 2550 6 0.043 26 0.5 15 27 2550 6 0.043 26 0.5 15 27 25550 6 0.043 26 0.5 15 27 25550 6 0.043 26 0.5 15 27 25550 6 0.043 26 0.05 15 27 25550 6 0.043 26 0.05 15 27 25550 6 0.043 26 0.05 15 27 25550 6 0.043 26 0.05 15 27 25550 6 0.043 26 0.05 15 27 25550 6 0.043 26 0.05 15 27 25550 6 0.043 26 0.05 15 27 25550 6 0.043 26 0.05 15 27 25550 6 0.043 26 0.05 15 27 25550 6 0.043 26 0.05 15 27 25550 6 0.043 26 0.05 15 27 25550 6 0.043 26 0.05 15 20 0.043 26 0.05 15 20 0.043 26 0.05 15 20 0.043 26 0.05 15 20 0.05 15 20 0.043 26 0.05 15 20 0.05 15 20 0.05 15 20 0.043 26 0.05 15 20	Benzene	900000	0.043	8	0.5	5	27	25550	1.094E-10
3.500E-05 5.000E-06 6.500E-04 7.200E-04 7.200E-04 7.200E-04 7.205E-0 7.200E-0 7.200E	Antimony, Dissolved	S. 2005 6 900E 04	0.03	8	0.5	15	27	25550	8.387E-09
trilofometriane 5.000E-06 0.043 26 0.5 15 27 2550 6 0.043 26 0.5 15 27 2550 6 0.043 26 0.5 15 27 2550 6 0.043 26 0.5 15 27 2550 6 0.043 26 0.5 15 27 2550 7 10.00E-05 0.043 26 0.5 15 27 2550 7 25550	Bromodichloromethane	3.450E.04	0.043	2 8	0.5	15	27	25550	4.193E-10
uran 0.000L-00 0.043 26 0.5 15 27 2550 lorobenzene 6.500E-01 0.043 26 0.5 15 27 2550 fetrachloride 1.000E-05 0.043 26 0.5 15 27 2550	Dibromochioromethane	5.430CF F 000F 06	0.043	3 8	0.5	15	27	25550	6.077E-11
orobenzene 6.500E-01 0.043 26 0.5 15 27 2550 16 1000E-05 0.043 26 0.5 15 27 2550 17 2550 18 18 19 19 19 19 19 19 19 19 19 19 19 19 19	Dibenzoturan	3.000E-04	0.043	2 %	0.5	5	27	25550	1.459E-09
etrachloride 1.000E-05 0.043 26 0.5 15 27 2550	1,4-Dichlorobenzene	8.500E-04	0.043	2 %	0.5	5	27	25550	7.901E-06
	Styrene Carbon Tetrachloride	1,000E-05	0.043	78 78	0.5	15	27	25550	1.215E-10
	Carbon lenacinonde								
	•								

TABLE P-28 EXPOSURE ASSESSMENT PARAMETERS - INGESTION OF SURFACE WATER Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

	RECREATIONAL	RECREATIONAL	
PARAMETER	ADULT	CHILD	
Exposure Time (hrs/day)	2.6	2.6	
Surface Water Contact Rate (ml/hr)	50	50	
Exposure Frequency (days/year)	48	48	
Exposure Duration (years)	25	15	
Body Weight, Kg	70	27	
Averaging Time			
Carcinogens	02	70	
Noncarcinogens	25	15	

TABLE P-29 DAILY INTAKE - ADULT SURFACE WATER INGESTION FUTURE LAND USE SCENARIO

Chemical	Chemical Concentration (mg/l)	Contact Rate (L/day)	Frequency (days/year)	Time (hrs/day)	Duration (years)	Weight (kg)	Time (days)	Rate (mg/Kg-day)
	1 60F-04	0.050	48	2.6	25	02	9125	3.908E-08
Derizerie Dissolved	90-300 B	0.050	48	2.6	25	20	9125	2.198E-09
Promodichloromethane	2.30E-05	0.050	48	2.6	25	70	9125	5.617E-09
Dibromochloromethane	1,50E-06	0.050	48	2.6	22	20	9125	3.663E-1
Dispussion	50-300 5	0.050	48	2.6	25	2	9125	1.221E-09
Ulberizoldiali	2 00E-06	0.050	48	2.6	25	20	9125	4.885E-1
1,4-01:11010051126116	6.50E-03	0.050	48	2.6	25	20	9125	1.587E-0
Stylene Carbon Tetrachloride	1.00E-05	0.050	48	2.6	25	20	9125	2.442E-0

TABLE P.30 DAILY INTAKE - CHILD SURFACE WATER INGESTION FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 1 Former POI, Facility, Albena CRTC, Albena MI

Dissolved horomethane sorbenzene (***Lobe**-04 (***Lobe**-04 (***Lobe**-04 (***Lobe**-04 (***Lobe**-04 (***Lobe**-05		Chemical Concentration	Contact Rate	Exposure Frequency	Exposure Time	Exposure Duration	Body Weight	Averaging	Intake Rate
1,60E-04 0.050 48 2.6 15 27 5475 9,00E-06 0.050 48 2.6 15 27 5475 2,30E-05 0.050 48 2.6 15 27 5475 5,00E-06 0.050 48 2.6 15 27 5475 2,00E-06 0.050 48 2.6 15 27 5475 6,50E-03 0.050 48 2.6 15 27 5475 1,00E-05 0.050 48 2.6 15 27 5475 1,00E-05 0.050 48 2.6 15 27 5475		(mg/l)	(L/day)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(mg/Kg-day)
9,00E-06 0,050 48 2.6 15 27 5475 2,30E-05 0,050 48 2.6 15 27 5475 1,50E-06 0,050 48 2.6 15 27 5475 2,00E-06 0,050 48 2.6 15 27 5475 2,00E-06 0,050 48 2.6 15 27 5475 6,50E-03 0,050 48 2.6 15 27 5475 1,00E-05 0,050 48 2.6 15 27 5475	Ç	1 60F-04	0.050	48	2.6	15	27	5475	1.013E-07
2.30E-05 0.050 48 2.6 15 27 5475 1.50E-06 0.050 48 2.6 15 27 5475 5.00E-06 0.050 48 2.6 15 27 5475 2.00E-06 0.050 48 2.6 15 27 5475 6.50E-03 0.050 48 2.6 15 27 5475 1.00E-05 0.050 48 2.6 15 27 5475		9 00E-06	0.050	48	2.6	15	27	5475	5.699E-09
1.50E-06 0.050 48 2.6 15 27 5475 5.00E-06 0.050 48 2.6 15 27 5475 2.00E-06 0.050 48 2.6 15 27 5475 6.50E-03 0.050 48 2.6 15 27 5475 1.00E-05 0.050 48 2.6 15 27 5475	riy, Dissolved	2.30E-05	0.050	48	2.6	15	27	5475	1.456E-08
5.00E-06 0.050 48 2.6 15 27 5475 2.00E-06 0.050 48 2.6 15 27 5475 6.50E-03 0.050 48 2.6 15 27 5475 1.00E-05 0.050 48 2.6 15 27 5475 5.0 15 27 5475		1.50E-06	0.050	48	2.6	15	27	5475	9.498E-10
2.00E-06 0.050 48 2.6 15 27 5475 6.50E-03 0.050 48 2.6 15 27 5475 1.00E-05 0.050 48 2.6 15 27 5475	ocilior officernal re	5.005-06	0.050	48	2.6	15	27	5475	3.166E-09
6.50E-03 0.050 48 2.6 15 27 5475 1.00E-05 0.050 48 2.6 15 27 5475	oruran , Fioroboxono	2.00E-06	0.050	48	2.6	5	27	5475	1.266E-09
etrachloride 1.00E-05 0.050 48 2.6 15 27 5475	HOLODERIZERIE	E:50E-03	0.050	48	2.6	15	27	5475	4.116E-06
	Tetrachloride	1.00E-05	0.050	48	2.6	15	27	5475	6.332E-09

TABLE P-31 DAILY INTAKE - ADULT SURFACE WATER INGESTION FUTURE LAND USE SCENARIO

	Chemical	Contact	Exposure	Exposure	Exposure	Body Weight	Averaging	Intake
Cnemical	(mg/l)	(L/day)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(mg/Kg-day)
Benzene	1.60E-04	0.050	48	2.6	25	70	25550	1.396E-08
Antimony Dissolved	9.00E-06	0,050	48	2.6	25	70	25550	7.850E-10
Bromodichloromethane	2.30E-05	0.050	48	2.6	25	70	25550	2.006E-09
Dibromochloromethane	1,50E-06	0.050	48	2.6	25	20	25550	1.308E-10
Dibenzofuran	5.00E-06	0.050	48	2.6	25	2	25550	4.361E-10
1.4-Dichlorobenzene	2.00E-06	0.050	48	2.6	25	20	25550	1.744E-10
Styrene	6.50E-03	0.050	48	2.6	25	20	25550	5.670E-07
Carbon Tetrachloride	1.00E-05	0.050	48	2.6	25	70	25550	8.722E-10

TABLE P-32 DAILY INTAKE - CHILD SURFACE WATER INGESTION FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 1 Former POI Facility, Albena CRTC, Albena MI

		(Ľ	Ľ	Ĺ	200		1
	Chemical	Contact	Exposure	Exposure	Cxposure	Moiabt	Averaging	Pate
Chemical	Concentration	rate :	rrequency	ALL I	Dayarion		(1117)	Canal Calana
	(l/gm)	(L/day)	(days/year)	(nrs/day)	(years)	(kg)	(days)	(mg/Ng-day)
Benzene	1.60E-04	0.050	48	2.6	15	27	. 25550	2.171E-08
Antimony, Dissolved	9.00E-06	0.050	48	2.6	15	27	25550	1.221E-09
Bromodichloromethane	2.30E-05	0.050	48	2.6	15	27	25550	3.121E-09
Dibromochloromethane	1.50E-06	0.050	48	2.6	15	27	25550	2.035E-10
Dibenzofuran	5.00E-06	0.050	48	2.6	15	27	25550	6.784E-10
1,4-Dichlorobenzene	2.00E-06	0.050	48	2.6	15	27	25550	2.714E-10
Styrene	6.50E-03	0.050	48	2.6	15	27	25550	8.819E-07
Carbon Tetrachloride	1.00E-05	0.050	48	2.6	15	27	25550	1.357E-09

TABLE P-33 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH THUNDERBAY RIVER SURFACE WATER Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	D
es Available for Contact (sq cm)		00
Exposure Time (his/day)	2.6 2.6	9.
Dermal Permeability Constant 0	0.0008	42
Exposure Frequency (days/year)	48	89
Exposure Duration (vears)	25	5
Body Weight, Kg	70	72
Averaging Time		
Carcinogens	70	2
Noncarcinogens	25	2
Conversion Factor	0.001	

P-34 DAILY INTAKE - ADULT SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

essyment RTC, Alpena MI	Chemical Dermal Skin Exposure Exposure Exposure Body Averaging Conversion Intake Concentration Permeability Surface Area Frequency Time Duration Weight Time Factor Rate (mg/l) (cm/hr) (sq cm) (days/year) (hrs/day) (years) (kg) (days) (Vcu cm) (mg/Kg-day)	1.600E-04 0.1 19400 48 2.6 25 70 9125 0.001 1.516E-06 9.000E-06 0.001 19400 48 2.6 25 70 9125 0.001 8.528E-10 2.300E-05 0.0058 19400 48 2.6 25 70 9125 0.001 1.264E-08 1.500E-06 0.0039 19400 48 2.6 25 70 9125 0.001 1.548E-08 5.000E-06 0.00084 19400 48 2.6 25 70 9125 0.001 1.175E-08 5.000E-06 0.0008-0 19400 48 2.6 25 70 9125 0.001 1.175E-08 6.500E-03 0.0008-0 19400 48 2.6 25 70 9125 0.001 5.174E-07 6.500E-03 0.0008-3 19400 48 2.6 25 70 9125 0.001 2.085E-08 1.000E-05 0.022 19
Noncarcinogenic Effect Exposure Assessment Site 1, Former POL Facility, Alpena CRTC, Alpena MI	Per	

P-35 DAILY INTAKE - CHILD SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Noncarcinogenic Effect Exposure Assessment Site 1. Former POL Facility, Alpena CRTC, Alpena MI

Site 1, rottlei POL raciity, Appella Civi C, Appella IIII	Civio, Openia in									
Chemical	Chemical Concentration (mg/kg)	Dermal Permeability (cm/hr)	Skin Surface Area (sq.cm)	Exposure Frequency (days/year)	Exposure Time (hrs/day)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Conversion Factor (Vcu cm)	Intake Rate (mg/Kg-day)
Benzene Antimony, Dissolved Bromodichlormethane Dibromochlormethane Dibenzofuran 1,4-Dichlorobenzene Styrene Carbon Tetrachloride	1.800E-04 9.000E-05 2.3000E-05 1.500E-06 5.000E-06 6.5000E-06 6.5000E-05 1.000E-05	0.1 0.001 0.0059 0.0039 0.00084 0.00084 0.0022	13300 13300 13300 13300 13300 13300 13300	4 4 4 4 8 8 8 4 4 8 8 8 8 4 4 8 8 8 8 8	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	£ £ £ £ £ £ £	222222	5475 5475 5475 5475 5475 5475	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	2.695E-06 1.516E-09 2.247E-08 9.853E-10 7.074E-10 2.088E-08 9.196E-07 3.705E-08
0_										

TABLE P-36 DAILY INTAKE - ADULT SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO

Chemical Concentration Dermal Permeability Skin Exposure Exposure Exposure Exposure Body Moraging Time Time Time Time Time Time Time Time	Chemical Concentration Dermal Permeability Curface Aira Skin Exposure Exposure Exposure Exposure Exposure Body (Mays) Averaging Averaging Conversion Conversion Time Factor Time	Chemical Concentration Dermal Permeability Surface Area (mg/l) Exposure (hrs/ldsy) Exposure (mg/l) Exposure (mg/l) Exposure (mg/l) Averaging (mg/lss) Conversion (mg/lss) Ownersality (mg/lss) Concentration (mg/lss) Permeability (mg/lss) Conversion (mg/lss) Image (mg/lss) Exposure (mg/lss) Exposure (mg/lss) Averaging (mg/lss) Conversion (mg/lss) Image (mg/ls	one i, ruillei roci aciny, Applia civic, Applia	or all charge in									
1.600E-04 0.1 19400 48 2.6 25 70 25550 9.000E-06 0.001 19400 48 2.6 25 70 25550 1.500E-06 0.0039 19400 48 2.6 25 70 25550 5.000E-06 0.0034 19400 48 2.6 25 70 25550 2.000E-06 0.0064 19400 48 2.6 25 70 25550 6.500E-06 0.0064 19400 48 2.6 25 70 25550 6.500E-06 0.0084 19400 48 2.6 25 70 25550 6.500E-03 0.0084 19400 48 2.6 25 70 25550	1.600E-04 0.1 19400 48 2.6 25 70 25550 0.001 9.000E-06 0.001 19400 48 2.6 25 70 25550 0.001 2.000E-06 0.0039 19400 48 2.6 25 70 25550 0.001 5.000E-06 0.00084 19400 48 2.6 25 70 25550 0.001 2.000E-06 0.00084 19400 48 2.6 25 70 25550 0.001 6.500E-03 0.00084 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.00084 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.00084 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.0022 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.022	1600E-04 0.1 19400 48 2.6 25 70 25550 0.001 9.000E-06 0.001 19400 48 2.6 25 70 25550 0.001 2.300E-06 0.0038 19400 48 2.6 25 70 25550 0.001 5.000E-06 0.0038 19400 48 2.6 25 70 25550 0.001 2.000E-06 0.00084 19400 48 2.6 25 70 25550 0.001 2.000E-06 0.00084 19400 48 2.6 25 70 25550 0.001 6.500E-06 0.00084 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.0022 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.022 19400 48 2.6 25 70 25550 0.001		Chemical Concentration (mg/l)	Dermal Permeability (cm/hr)	Skin Surface Area (sq cm)	Exposure Frequency (days/year)	Exposure Time (hrs/day)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Conversion Factor (Vcu cm)	Intake Rate (mg/Kg-day)
0.001 19400 48 2.6 25 70 25550 0.0058 19400 48 2.6 25 70 25550 0.00084 19400 48 2.6 25 70 25550	1.000E-04 0.01 19400 48 2.6 25 70 25550 0.001 2.300E-05 0.0058 19400 48 2.6 25 70 25550 0.001 1.500E-06 0.0008-4 19400 48 2.6 25 70 25550 0.001 2.000E-06 0.0008-4 19400 48 2.6 25 70 25550 0.001 2.000E-06 0.0008-4 19400 48 2.6 25 70 25550 0.001 6.500E-03 0.0008-4 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.0022 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.0022 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.0022 19400 48 2.6 25 70 25550 0.001	1.000E-04 0.001 19400 48 2.6 25 70 25550 0.001 2.5 10 0.0		70 1000 7		19400	48	90	25	20	25550	0.001	5.415E-07
2.000E-06 0.0058 19400 48 2.6 25 70 25550 1500E-06 0.0039 19400 48 2.6 25 70 25550 2500E-06 0.00084 19400 48 2.6 25 70 25550 2500E-06 0.00084 19400 48 2.6 25 70 25550 2550 2550 2550 2550 2550 25	9.000E-06 0.0038 19400 48 2.6 25 70 25550 0.001 1.500E-06 0.0038 19400 48 2.6 25 70 25550 0.001 2.000E-06 0.00084 19400 48 2.6 25 70 25550 0.001 2.000E-06 0.00084 19400 48 2.6 25 70 25550 0.001 6.500E-03 0.00084 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.0002 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.00084 19400 48 2.6 25 70 25550 0.001	2.00E-06 0.0038 19400 48 2.6 25 70 25550 0.001 1.500E-06 0.0039 19400 48 2.6 25 70 25550 0.001 5.000E-06 0.00084 19400 48 2.6 25 70 25550 0.001 2.000E-06 0.00084 19400 48 2.6 25 70 25550 0.001 6.500E-03 0.00084 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.022 19400 48 2.6 25 70 25550 0.001		1.50005-04		19400	84	2.6	22 22	2	25550	0.001	3.046E-10
1.500E-05 0.0039 19400 48 2.6 25 70 25550 5.000E-06 0.00084 19400 48 2.6 25 70 25550 2.000E-06 0.0062 19400 48 2.6 25 70 25550 6.500E-03 0.00084 19400 48 2.6 25 70 25550 6.500E-03 0.00084 19400 48 2.6 25 70 25550	1.500E-05 0.0039 19400 48 2.6 25 70 25550 0.001 5.000E-06 0.00084 19400 48 2.6 25 70 25550 0.001 2.000E-06 0.002 19400 48 2.6 25 70 25550 0.001 6.500E-03 0.00084 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.022 19400 48 2.6 25 70 25550 0.001 1.000E-05 0.022 19400 48 2.6 25 70 25550 0.001	1.000E-05 0.0039 19400 48 2.6 25 70 25550 0.001 0.001 0.001 0.0039 19400 48 2.6 25 70 25550 0.001 0.001 0.002-06 0.00084 19400 48 2.6 25 70 25550 0.001 0.001 0.002 0.001 0.002 0.001 0.002 0.002 19400 48 2.6 25 70 25550 0.001 0.001 0.002 0.002 19400 48 2.6 25 70 25550 0.001 0.001 0.002 0.	Dissolved	9.000000	00.0	19400	48	2.6	52	2	25550	0.001	4.515E-09
inzene 5.000E-06 0.00084 19400 48 2.6 25 70 25550 2000E-06 0.0062 19400 48 2.6 25 70 25550 2000E-06 0.0062 19400 48 2.6 25 70 25550 2000E-06 0.0064 19400 48 2.6 25 70 25550 2000E-06 0.00084 19400 48 2.6 25 70 25550 200E-06 0.00084 19400 48 2.6 2.6 25 70 25550 200E-06 0.00084 19400 48 2.6 2.6 25 70 25550 200E-06 0.00084 19400 48 2.6 2.6 25 70 25550 200E-06 0.00084 19400 48 2.6 2.6 25 70 25550 200E-06 0.00084 19400 48 2.6 2.6 2.6 2.5 70 25550 200E-06 0.00084 19400 48 2.6 2.6 2.5 70 25550 200E-06 0.00084 19400 48 2.6 2.6 2.5 70 25550 200E-06 0.00084 19400 48 2.6 2.6 2.5 70 25550 200E-06 0.00084 19400 48 2.6 2.6 2.5 70 25550 200E-06 0.00084 19400 48 2.6 2.6 2.5 70 25550 200E-06 0.00084 19400 48 2.6 2.6 2.5 70 25550 200E-06 0.00084 19400 48 2.6 2.6 2.5 70 25550 200E-06 0.00084 19400 48 2.6 2.6 2.5 70 25550 200E-06 0.00084 19400 48 2.6 2.6 2.5 70 200E-06 0.00084 19400 48 2.6 2.6 2.5 70 200E-06 0.00084 19400 48 2.6 2.6 2.5 70 200E-06 0	instrant (1900 48 2.6 25 70 25550 0.001 (1900 48 2.6 25 70 25550 0.001 (1900 48 2.6 25 70 25550 0.001 (1900 48 2.6 25 70 25550 0.001 (1900 48 2.6 25 70 25550 0.001 (1900 48 2.6 25 70 25550 0.001 (1900 48 2.6 25 70 25550 0.001 (1900 48 2.6 25 70 25550 0.001 (1900 48 2.6 25 70 25550 0.001 (1900 48 2.6 25 70 25550 0.001 (1900 48 2.6 25 70 25550 0.001 (1900 48 2.6 25 25 25 25 25 25 2550 0.001 (1900 48 2.6 25 25 25 25 25 25 25 25 25 25 25 25 25	inzene 5.000E-06 0.00084 19400 48 2.6 25 70 25550 0.001 2.000E-06 0.00084 19400 48 2.6 25 70 25550 0.001 6.500E-08 0.00084 19400 48 2.6 25 70 25550 0.001 6.500E-03 0.00084 19400 48 2.6 25 70 25550 0.001 6.500E-03 0.0022 19400 48 2.6 25 70 25550 0.001 6.500E-05 0.0022 19400 48 2.6 25 70 25550 0.001	loromethane	4.500E-03	0.0030	19400	48	26	25	20	25550	0.001	1.980E-10
3,000E-06 0,000E-0	nozere 2.000E-06 0.062 19400 48 2.6 25 70 25550 0.001 hloride 1.000E-05 0.022 19400 48 2.6 25 70 25550 0.001 nloride 1.000E-05 0.022 19400 48 2.6 25 70 25550 0.001	nzene 2,000E-06 0,002 19400 48 2.6 25 70 25550 0,001 6.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5 5.5	lorometnane	5 200E 06	280000	19400	48	26	25	20	25550	0.001	1.421E-10
2,000E-09 0.0084 19400 48 2.6 25 70 25550	6,500E-05 0,00084 19400 48 2.6 25 70 25550 0,001 1,000E-05 0,022 19400 48 2.6 25 70 25550 0,001	6.500E-05 0.022 19400 48 2.6 25 70 25550 0.001	LI B	90-2000.0	0.0004	19400	48	2.8	52	2	25550	0.001	4.197E-09
25550	6,500E-55 0,002 19400 48 2.6 25 70 25550 0,001	0.00E-05 0.022 19400 48 2.6 25 70 25550 0.001	openzene	2.00000-00	20000	19400	48	26	52	02	25550	0.001	1.848E-07
1.000E-05 0.022 19400 46 2.0 20			rachloride	1.000E-05	0.022	19400	48	2.6	25	70	25550	0.001	7.445E-09

TABLE P-37 DAILY INTAKE - CHILD SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO Carcinogenic Effect Exposure Assessment

	Intake Rate mg/Kg-day)	5.775E-07 3.248E-10 4.815E-09 2.111E-10 1.516E-10 4.475E-09 1.971E-07
	٦	
	Conversion Factor (Vcu cm)	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0
	Averaging Time (days)	25550 25550 25550 25550 25550 25550 25550 25550
	Body Weight (kg)	33333333
	Exposure Duration (years)	£ £ £ £ £ £ £
	Exposure Time (hrs/day)	2 2 5 6 2 2 5 6 2 2 5 6 2 5 6 5 5 5 6 5 5 6 5 6
	Exposure Frequency (days/year)	4 4 4 4 8 8 8 4 8 8 8 8 8 8 8 8 8 8 8 8
	Skin Surface Area (sq cm)	13300 13300 13300 13300 13300 13300
	Dermal Permeability (cm/hr)	0.1 0.001 0.0058 0.0039 0.00084 0.00084 0.00084
CRTC, Alpena MI	Chemical Concentration	1.600E-04 9.000E-05 2.300E-05 1.500E-06 5.000E-06 6.500E-03 1.000E-03
Site 1, Former POL Facility, Alpena CRTC, Alpena Mi	Chemical	Benzene Antimony, Dissolved Bromodichloromethane Dibromochloromethane Dibromochloromethane 1,4-Dichlorobenzene Styrene Carbon Tetrachloride

TABLE P-38 EXPOSURE ASSESSMENT PARAMETERS - SOIL INHALATION Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

PARAMETER	EXCAVATION WORKER
Inhalation Rate, (mg/cu m)	83
Exposure Time (hours/day)	ω
Exposure Frequency (days/year)	250
Exposure Duration (years)	90'0
Body Weight (kilograms)	02
Averaging Time (years)	
Carcinogens	70
Noncarcinogens	0.08

TABLE P-39 DAILY INTAKE - ADULT SOIL INHALATION FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

Noncarcinogenic Effect Exposure Assessment Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

				1	i			
		Exposure	Inhalation	Exposure	Exposure			
Chemica	Concentration	Duration	Rate	Time	Frequency	Weight	Time	intake Rate
	(ma/cn m)	(years)	(cn m/hr)	(hours/day)	(days/yr)	(kg)	(days)	(mg/kg-day)
Oblorobonzono	5 166F-02	0.08	8	æ	220	20	29.2	8.087E-02
CHINIODENIZERIE	3.912F-02	0.08	8	80	250	2	29.2	6.124E-02
Styrene	3.460E-02	0.08	8	80	250	70	29.5	5.416E-02

TABLE P-40 DAILY INTAKE - ADULT SOIL INHALATION FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

70 25550		N.	00	8		3.460E-02	Styrene
70 25550	0	25	80	8		3.912E-02	Ethylbenzene
70 25550	0	X	80	8		5.166E-02	Chlorobenzene
		(days/yr	(hours/day)	(cn m/hr)		(ma/cn m)	
	>	Frequenc	Time	Rate		Concentration	Chemical
	•	Exposure	Exposure	Inhalation	ш		
int Time (days) (days) 70 25550 70 25550	Weight (kg) 70 70	Exposure Frequency (days/yr) 250 250	Exposure Time (hours/day) 8	Inhalation Rate (cu m/hr) 20	Exposure Duration (years) 0.08	Concentration (mg/cu m) 5.166E-02 3.912E-02	

TABLE P-41 SOIL INHALATION MODEL CALCULATIONS Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

Total depth of soil Wind Velocity Gas Constant Ambient Temperature	6550 ft²2 100 ft 62.5 ft 1 ft 353 cm/sec 62300 mm hg-cm²3/mol-k 233 K		6090000 3048 cm 1905 cm 30.48 cm	
Computations C(I), mg/kg W(I), W(I), g	Chlorobenzene 3.163170E+03 0.0311631697 7271251.3532943 0.075 112.56 8.75 0.9	Ethylbenzene 3,97036;10E+03 0,0397036;102 9263978;3493339 0,0658 106;16 7,5	Styrene 3,9202328+03 0.039202324 9147013,9211972 0.077 104,16 6,25 0.9	
initial Values, no soil cap E(i,j), g/sec C(air,j), mg/m³3) Time (i,j), hr	3.47E+01 2.58E-02 1.91E+00	2.63E+01 1.96E-02 3.21E+00	2.33E+01 1.73E-02 3.58E+00	

P-33

TABLE P-42 SOIL INHALATION MODEL CALCULATIONS Site 1, Former POL Facility, Alpena CRTG, Alpena, MI

Soil Density Excavated soil area Length in wind direction Width across wind direction Total depth of soil Wind Velocity Gas Constant Ambient Temperature	1.257 g/cm ³ 5900 ft ² 100 ft 50 ft 1 ft 353 cm/sec 62300 mm hg-cm ³ /mol-k 293 K		78.46 lbff*3 540000 cm 30.48 cm 1524 cm 30.48 cm
Computations C(i), mg/kg W(i), wg/g W(i), g/g Wix, i) arlem	Chlorobenzene 3116.31697 0.0311631697 6447414.9930688	Ethylbenzene 3970.36102 0.0397036102 8214365.0388183	Styrene 3920.23234 0.0392023234 8110652.7380074
M(), cm/2/sec M(), g/mol p()) @293K, mm Hg F(V), dimensionless	0.075 112.56 8.75 0.9	0.0658 106.16 7.5 0.9	0.077 104.16 6.25 0.9
Initial Values, no soil cap E(i,j.), g/sec C(air,ij.), mg/m^3) Time (i,j.), hr	2.78E+01 2.58E-02 2.11E+00	2.10E+01 1.96E-02 3.56E+00	1.86E+01 1.73E-02 3.97E+00

TABLE P43 CANCER ESTRATE - GROUNDWATER INGESTION SHALLOW AQUIFER PRODUCTION WELL FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

		Site 1, Former PUL Fadility, Alberta CK1C, Alberta, IVI						Adut Chemical-	Total	Children Chemical-	Total
		CDI		SF (mg/kg-day)^-1	Weight of Evidence	Type of Cancer	Source	Specific	Pathway Risk	Spedific Rask	Pathway Risk
Chemical (mg	$\overline{}$	mg/kg-day)	- 1		4	l or from a	IRIS 93	7E-08		2E-08	
	2.249E-06	5.636E-07		0.029	•			0E+00		0E+00	
Dissolved	1.166E-05	2 922E-06		NO EVIDENCE		ive.	IRIS 93	5E-09		1E-09	
92	7.498E-08	1.879E-08		0.062	28			0E+00		0E+00	
	2.166E-07	5.427E-08		NO EVIDENCE				0F+00		0E+00	
	4.166E-08	1.044E-08		NO EVIDENCE	(short trace	HFAST FY93	3E-10		8E-11	
anzene	1.250E-08	3.131E-09		0.024	ر			0E+00		0E+00	
	2.166E-08	5.427E-09	2 2	NO EVIDENCE 0 13	82	Heptocelluar cardinomas		1E-06		3E-07	
Sarbon Tetrachionde	8.837 E-00	4.303E-20							5		35.07

TABLE P44 CHRONC HAZARDOUS INDEX ESTMATE GROUNDWATER INGESTION SHALLOW AQUIFER PRODUCTION WELL FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncardinogenic Effects Site 1, Former POL Facili	Noncardinogeric Effects Site 1, Former POL Facility, Apena CRTC, Alpena, MI	MI, MI									
								Adult		Children	
								Chemical-	Total	Chemical-	Total
	Actut	Onild	CD	RfD	Critical	RfD	Modfylng	Spedfic	Pathway	Spedific	Pathway
	Ö	Ō	Adusted for	(mg/kg-day)	Effect	Sorrce	Factor	AS S	AS A	AS S	Risk
Chemical	(mg/kg-day)	(mg/kg-day)	Absorption								
Benzene	6.298E-06	2.630E-06	ON	NODATA	AM	AN	AN				
Antimony, Dissolved	3.266E-05	1.364E-05	ON	0.0004	Reducedlifespan	IRIS 93		8E-02		3E-02	
Bromodichioromethane	2.099E-07	8.767E-08	2	0.02	Renal cytomegaly	IRIS 93	-	1E-05		4F-06	
Dibromochloromethane	1.166E-07	2.533E-07	QN	0.02	Hepatic lesions	IRIS 93		90-39		1F-05	
Dibenzofuran	1.166E-07	4.871E-08	ON	NODATA	A/Z	A Z	AZ				
1,4-Dichlorobenzene	3.499E-08	1.461E-08	ON	NODATA	₹Z	¥ Z	¥ Z				
Styrene	6.065E-08	2.533E-08	ON	0.2	Hepatotoxicity	(RIS 93	-	3E-07		1F-07	-
Carbon Tetrachloride	2.799E-05	1.169E-05	ON.	0.0007	Liver Lesions	IRIS 93	-	4E-02		2E-02	
Total									10		2

TABLE P46 CANCER ESTIMATE - GROUNDWATER INHALATION SHALLOW AQUIFER FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Stell Former POL Facility, Albana Chilly, Albana, Mil	IV MAIN OUT OF THE	S RO IVI						Adult	•		+
	3 1	7	S					Chemical-	Loto	Chemical	, 1
	Agur	2	A de sepa for	ш	Weight of	Type of	SF	Spedic	Pathway	Specific	Pathway
	5.		-	(man-day)-1	Furbonce	Carcer	Source	Risk	Zi Si	ASK A	2
nical	(mg/kg-day)		1	Tan Suni	V	a kemia	IRIS 1993	2E-08		6E-09	
enzene	7.649E-07		2	670.0	τ			0F+00		0E+00	
dimory. Dissolved	0.000E+00			NO EVIDENCE	ç	NIA (4)	1003	2F-09		4E-10	
romodichloromethane	2.550E-08			0.062	28	(1) KN	IDIC 1003	90 18		2E-09	
bromochloromethane	7.366E-08			0.084	ن د	(1) YN	200 (00)	00-10		0E+00	
ibenzofuan	0.000E+00			NODAIA	(472	IRIS 1993	2E-10		4E-11	
4-Dichlorobenzene	4.250E-09			0.04	ر	2		0F+00		0E+00	
Styrene	7.366E-09	1.846E-09	2 2	NO EVIDENCE	B2	Cardnogericity (rat, mouse, hamster)	IRIS, 1993	2E-07		5E-08	

(1) Oral slope factor was used.

TABLE P.48 CHRONC HAZARDOUS INDEX ESTRATE - GROUNDWATER INHALATION SHALLOW AQUIFER FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncardinogeric Effects Site 1, Former POL Fadility, Alpena CRTC, Alpena, MI	is diity, Alpena CRTC, Alg	pera, Mi									
								Adut	Total	Children	Total
	Adult	PINO	Q)	R	Oritical	02	Modfying	Specific	Pathway	Specific	Pathway
	3	0	Actusted for	(mg/kg-day)	Effect	Source	Factor	- W	, in	A Section	No.
Chemical	(mg/kg-day)	(mg/kg-day)	Absorption								
Benzene	2.142E-06	8.944E-07	ON	NODATA	AN	IRIS, chronic oral RfD used	NA NA				
Antimony, Dissolved	0.000E+00		9	0 0004	AZ.	IRIS, chronic oral RfD used	AN	0F+00		0F+00	
Bromodichloromethane	7.139E-08		ON N	0.02	4Z	IRIS, chronic oral RfD used	Y.	4F-06		1F-06	
Dibromochloromethane	2.062E-07		ON	0.02	AZ.	IRIS dyonic oral RID used	Ϋ́	1F-05		4F-06	
Dibenzofuran	0.000E+00		ON	AN	AZ.	IRIS, chronic oral RfD used	ď				
1,4-Dichlorobenzene	1.190E-08	4.969E-09	NON	0.2	Liver, Kichey	HEAST 93	¥Z	6E-08		2E-08	
Styrene	2.062E-08		9	-	NA	t	AN	2F-08		9F-09	
Carbon Tetrachloride	9.519E-06		9	0.0007	NA V	IRIS, chronic oral RfD used	Y N	1E-02		65-03	
Total									1E-02		6E-03

TABLE P-47 CANCER ESTEMATE - DERMAL CONTACT WITH GROUNDWATER FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Cardrogeric Effects Site 1 Former POL Facility, Alpena CRTC, Alpena, MI	CRTC, Alpen	BA, MI						Adul		PINO	
								Chemical-	Total	Chemical-	Total
	Adut	P O	CDI Adusted for		Weight of	Type of	SF	Spedic	Pathway	Specific	Pathway
(mu)	(Vec-chv)	(ma/ka-day)	Absorption		Evidence	Carce	ibic 03	2E-08		3E-09	
	5,455E-07		YES		A	Leukemia	IXIS 93	0E+00		0E+00	
	2.828E-08		YES	NO EVIDENCE	2	- PACT	IRIS 93	7E-11		1E-11	
3romod chloromethane	1.055E-09		Y Y	20-355.0 30-350.03	70	İ		0E+00		00+30	
	2.049E-09		V Y	NO EVIDENCE				0E+00		0E+00	
	1 879F-09		YES	2.40E-02	υ	Liver fumors	HEAST FY93	5E-11		0E+00	
Syrene	4.412E-11	7.579E-12 9.162E-08	YES	NO EVIDENCE 1.30E-01	B2	Heptocellular cardinomas		7E-08	9E-08	1E-08	1E-08

*Adjusted from administered to absorbed dose using an oral absorption efficiency factor. Benzene =1,Bromoclotriormehane = 0,98, 1,4 DCB=1, CCI4=05,

TABLE P48 CHRONIC HAZARDOUS INDEX ESTMATE - DERMAL CONTACT WITH GROUNDWATER FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncardingeric Effects Site 1, Former POL Facility, Apera CRTC, Alpera, MI

								Adult		PINO	
	Adult	Địc G	Ō					Chemical-	Total	Chemical-	Total
	Ō	00	Adjusted for	RND.	Orifical	RrD	Modfying	Specific	Pathway	Specific	Pathway
Chemical	(mg/kg-day)	٤	Absorption	(mg/kg-day)	Effect	Source	Factor	Risk	N. N.	- X	Risk
Benzene	1.527E-06	Į	YES	NO DATA	NA.	₹Z	NA				
Artimorry, Dissolved	7.919E-08		YES	2E-05	Reducedlifespan	IRIS 93		4E-03		1E-03	
Bromodichioromethane	2.953E-09		YES	0.0196	Renal cytomegaly	IRIS 93	-	2E-07		4E-08	
Dibromochloromethane	5.736E-09		YES	0.02	Hepatic lesions	IRIS 93		3E-07		86-08	
Dibenzofuran	2.376E-10		YES	NO DATA	NA.	₹Z	AN.				
1.4-Dichlorobenzene	5.261E-09	1.506E-09	YES	NO DATA	ΥN	42	₹Z				
Styrene	1,235E-10		YES	0.01	Hepatotoxicity	IRIS 93	-	1E-08		4E-09	
Carbon Tetrachloride	1.493E-06		YES	3.5E-05	Liver Lesions	IRIS 93	-	4E-02		1E-02	
Total									5E-02		1E-02

TABLE P-49 CANCER ESTIMATE - DERMAL CONTACT WITH SOILS FUTURE LAND USE SCENARIO - ADULTS

Carcinogenic Effects Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

Weight of Type of SF Specific Pathway Evidence Cancer Source Risk Risk Risk Risk 0E+00 0E+00 0E+00 0E+00
Type of SF Specific Cancer Source Risk 0E+00 0E+00 0E+00
Type of SF Specific Cancer Source Risk 0E+00 0E+00
Cancer Source Risk 0E+00 0E+00 0E+00 0E+00
0E+00 0E+00
00+100

^{*}Styrene classified as possible human carcinogen by IRAC. No slope factor has been adopted as of 12/08/93.

TABLE P-60 SUBCHRONIC HAZARDOUS INDEX ESTIMATE - DERMAL CONTACT WITH SOILS FUTURE LAND USE SCENARIO - ADULTS

Noncarcinogenic Effects Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

	Excavation							
	Worker	CD					Chemical-	Total
	CO	Adjusted for	RfD*	Critical	RfD	Modifying	Specific	Pathway
Chemical	(mg/kg-day)		(mg/kg-day)	Effect	Source	Factor	Risk	Risk Sist
Chlorobenzene	6.588E-05		0.01	Liver	HEAST FY93	1	7E-03	
Ethylbenzene	8.394E-05		0.085	Liver and Kidney	HEAST FY93	_	1E-03	
Styrene	8.288E-05		0.01	Liver	IRIS 93	-	8E-03	
Total								2F-02

*RfD adjusted from administered to absorbed dose using an absorption efficiency of 5%, unless a chemical specific efficiency was available. Ethylbenzene 85% efficiency used.

TABLE P-51 CANCER ESTIMATE - SOIL INGESTION FUTURE LAND USE SCENARIO - EXCAVATION WORKER

	Excavation							
	Worker	G					Chemical-	Total
	CDI	Adjusted for	R	Weight of	Type of	SF	Specific	Pathway
homical	(ma/ka-dav)	Absorption	(mg/kg-day)^-1	Evidence	Cancer	Source	Risk	Ris
let illedi	1 673F-05	2	NO EVIDENCE				0E+00	
THOUGHT SEATE	2 1315-05	S	NO EVIDENCE				0E+00	
Ethylbenzene	2 104E-05	2	NO EVIDENCE(1)				0E+00	
Styrene	2. 12.1.3							0E+00

(1) Classified by IRAC as possible human carcinogen. No SF has been adopted as of 12/08/93.

TABLE P-52 SUBCHRONIC HAZARDOUS INDEX ESTIMATE - SOIL INGESTION FUTURE LAND USE SCENARIO - EXCAVATION WORKER

Noncarcinogenic Effects
Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

	2E-05 1E-04		HEAST FY93 (RIS 93	Liver and Kidney Red Blood Cell, Liver	0.2	<u> </u>	2.13E-05 2.10E-05	lbenzene
	8E-05	-	HEAST FY93	Liver	0.2	ON N	1.67E-05	hlorobenzene
						Absorption	(mg/kg-day)	
Risk	Risk	Factor	Source	Effect	(mg/kg-day)	Adjusted for	CDI	
Pathway	Specific	Modifying	RfD	Critical	RfD	CDI	Worker	
Total	Chemical-				Subchronic		Excavation	

No subchronic RfD available as of 12/08/93. Chronic RfD used.

STE15,WB1/840127

TABLE P-53 CANCER ESTIMATE - FISH INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

	Adult	Adult Chiid	CDI Adjusted for	R	Weight of	Type of	S	Adult Chemical- Specific	Total Pathway	Chemical- Specific Specific	Total Pathway Risk
Chemical (mg/ Benzene 3 Artimony, Dissolved 8 Bromodifutormethane 6 Dibromochloromethane 3 Olbenzofuran 4 I.4-Dichlorobenzene 1 Characterian 4	(mg/kg-day), (mg/kg-day), 3.77E-08 4.67E-0 8.83E-11 1.09E-1 8.39E-10 4.18E-1 4.31E-11 6.08E-1 1.18E-09 1.46E-0 6.88E-09 7.90E-0	(/kg-day) 4.67E-08 8.38E-09 4.19E-10 6.08E-11 1.46E-09 7.90E-08	Absorption (mg/kg NO NO EV	ng/vg-asy)*-1 0.029 0.029 0.062 0.062 0.062 0.034 0.034	A A B2 C C	Leukemia Liver Liver tumors	IRIS 93 IRIS 93 HEAST FY93	0E+00 0E+00 0E+00 0E+00 0E+00 0E+00 0E+00		0E+00 1E-09 0E+00 5E-10 0E+00 0E+00 0E+00	
Tetrachloride	9.81E-11	1.22E-10	ON .	0.13	82	Heptocellular carcinomas		1E-11		7E-11	

TABLE P-54 CHRONIC HAZARDOUS INDEX ESTIMATE - FISH INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

	Adult	Child	CD					Adult Chemical	Total	Children Chemical	Total
Chemical	CDI CDI (mg/kg-day) (mg/kg-day)	CDI (mg/kg-day)	Adjusted for Absorption	RfD (mg/kg-day)	Critical Effect	RfD Source	Modifying Factor	Specific	Pathway Risk	Specific	Pathway
Benzene	1.06E-07	2.18E-07	ON	NO DATA	AM	AN	e z				
Antimony, Dissolved	2.47E-10	5.11E-10	ON	0.0004	Reduced lifespan	IRIS 93		8E-07		1E-08	
Bromodichioromethane	1.90E-08	3.91E-08	ON	0.02	Renal cytomegaly	IRIS 93	_	9E-07		2E-06	
Dibromochloromethane	9.48E-10	1.96E-09	ON NO	0.02	Hepatic lesions	IRIS 93	-	5E-08		1E-07	
Dibenzofuran	1.37E-10	2.84E-10	ON	NO DATA	NA.	AN	AN				
.4-Dichlorobenzene	3.30E-09	6.81E-09	ON	NO DATA	AN	AN	AN				
Styrene	1.79E-05	3.69E-05	ON N	0.2	Hepatotoxicity	IRIS 93	-	9E-05		2F-04	
Carbon Tetrachloride	2.75E-10	5.67E-10	ON	0.0007	Liver Lesions	IRIS 93	-	4E-07		8E-07	
Total									9E.05		2E.04

TABLE P-65 CANCER ESTMATE - SURFACE WATER INCESTON FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Adult (mg/kg-dwf) CDI (mg/	Ste 1, romer PCL ra	Ste 1, Former POL Facility, Apple to CNIC, Apple to Mil	CI MI						Adut		Children	
CDI		1 1	177	ξ					Chemical-		Chemical-	Total
Mark Grands		ig ig	50	Adusted for	SF	Weight of	Type of	₽S.	Spediic		Spedic	Pathway
139E-08	-	(moveo-day)	(marka-cav)	Absorption	(ma/ka-day)^-1	Evidence	Cancer	Source	Rsk		¥SP.	¥ P
1.396E-08 2.171E-08 NO NO EVIDENCE B2 1.21E-09 NO NO EVIDENCE C 1.30E-10 1.74E-10 1.30E-10 1.30E-10 1.30F-10 NO NO EVIDENCE C 1.30E-10 1.30F-10 NO NO EVIDENCE C 1.30E-10 1.30F-10 NO NO EVIDENCE C 1.30E-10 1.30F-10 1.30F-20 NO NO EVIDENCE B2 HERROCHIJAT CATICTOMAS NO NO EVIDENCE B2 HERROCHIJAT CATICTOMAS NO NO EVIDENCE B2 HERROCHIJAT CATICTOMAS NEW 1.E-10 1.30F-20 NO NO EVIDENCE B2 HERROCHIJAT CATICTOMAS NEW 1.E-10 1.30F-20 NO NO EVIDENCE B2 HERROCHIJAT CATICTOMAS NEW 1.E-10 1.30F-20 NO NO EVIDENCE B2 HERROCHIJAT CATICTOMAS NEW 1.E-10 1.30F-20 NO NO EVIDENCE B2 HERROCHIJAT CATICTOMAS NEW 1.E-10 1.30F-20 NO NO EVIDENCE B2 HERROCHIJAT CATICTOMAS NEW 1.E-10 1.30F-20 NO NO EVIDENCE B2 HERROCHIJAT CATICTOMAS NEW 1.E-10 1.30F-20 NO NO EVIDENCE B2 HERROCHIJAT CATICTOMAS NEW 1.E-10 NO NO EVIDENCE B2 NEW 1.20F-20 NO NO NO EVIDENCE B2 NEW 1.20F-20 NO NO EVIDENCE B2 NEW 1.20F-20 NO NO NO EVIDENCE B2 NEW 1.20F-20 NO NO NO EVIDENCE B2 NEW 1.20F-20 NO NO NO EVIDENCE B2 NO NO NO EVIDEN	Viemical	San Subini	The Bushing						0E+00		0E+00	
7.535E-10 1.221E-39 NO NO EVIDENCE B2 Liver IRIS 93 0E+00 2.006E-09 3.121E-09 NO 062 B2 Liver IRIS 93 0E+00 2.006E-09 3.121E-09 NO NO EVIDENCE C Liver tumors HEAST FY93 0E+00 3.676E-10 2.74E-10 NO NO EVIDENCE C Liver tumors HEAST FY93 0E+00 5.670E-07 8.819E-07 NO NO EVIDENCE B2 Heptocellular cardromas 1E-10		4 30cF 08	2 171E OB	2	9200	ď	Leukemia	IRIS 93	4E-10		6E-10	
1.252E-10 1.357E-59 NO NO EVIDENCE B2 Uver turnors 1E-10 CE+00 CE+000 CE+000 CE+000 CE+000 CE+000 CE+000 CE+000 CE+000 CE+00	erzene	1,030 1	4 2215 00	2 2	NO EVIDENCE				0E+00		0E+00	
Ordinaterials 2.035E-10 NO NO EVIDENCE C Divertumors HEAST FY93 0E+00 0E+00	ritimorry, Ussaved	01-2000.0	2 121E-03	2 2	0.062	B2	Liver	IRIS 93	1E-10		2E-10	
Activity of the control of the contr	romodicator ornemane	Z.000E-03	0.12.E.00	2 2	BOUNDANCE ON	1			0E+00		0E+00	
User tumors HEAST FY93 4E-12 Licoberizore Liver tumors HEAST FY93 4E-12 Licoberizore 174E-10 NO 0024 C Liver tumors HEAST FY93 4E-12 Reproceituar carcinomas 5670E-07 8.819E-07 NO NO EVIDENCE BZ Heptoceltuar carcinomas 1E-10 Tetractrioride 8.722E-10 1.357E-09 NO 0.13 BZ Heptoceltuar carcinomas	Noromochioromethane	1.300E-10	2.033E*10	2 2	NO EVIDENCE				0E+00		0E+00	
Incoberzere 1,748-10 2,748-10 0,024	ibenzoluran	4.301E-10	6.704E-10	2 5	יאים ראים רו	(i ivor h more	HEAST EVOR	4F-12		7E-12	
5670E-07 8.819E-07 NO NO EVIDENCE B2 Heptocellular carcinomas UE-10 Tetractrioride 8.722E-10 1,357E-09 NO 0,13 B2 Heptocellular carcinomas UE-10	4-Dichlorobenzene	1.744E-10	2.714E-10	2	0.024	ט			100		סבייטט	
Tetrachioride 8,722E-10 1,357E-09 NO 0.13 B2 Heptocellular carcinomas 1E-10	tyrene	5.670E-07	8.819E-07	9	NO EVIDENCE				מבינו		200	
	arbon Tetrachloride	8.722E-10	1.357E-09	9	0.13	B2	Heptocellular cardinomas		1E-10		0L-37	
										6E-10		1E-09

TABLE P-66 CHRONG HAZARDOUS INDEX ESTMATE - SURFACE WATER INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN	Noncardinogeric Effects Site 1, Former POL Facility, Alpena CRTC, Alpena, MI
FUTURE LAN	Noncardinogerio

								Adult		Children	
	Adult	S.	3					Chemical-	Total	Chemical-	Total
	īg)	Ō	Adjusted for	RED	Critical	RfD	Modifying	Spedic	Pathway	Specific	Pathway
Chemical	(mg/kg-day)	(mg/kg-day)	Absorption	(mg/kg-day)	Effect	Source	Factor	Risk	Risk	Rask	Pask
Benzene	3.908E-08	1.013E-07	ON N	NO DATA	NA	A'N	ď Z				
Antimony, Dissolved	2.198E-09	5.699E-09	ON N	0.0004	Reducedlifespan	IRIS 93		5E-06		1E-05	
Bromodichloromethane	5.617E-09	1,456E-08	ON	0.02	Renal cytomegaly	IRIS 93	-	3E-07		7E-07	
Dibromochloromethane	3.663E-10	9.498E-10	ON N	0.02	Hepaticlesions	IRIS 93	-	2E-08		5E-08	
Dibenzofuran	1.221E-09	3.166E-09	ON	NO DATA	AN.	₹Z	NA				
I,4-Dichlorobenzene	4.885E-10	1.266E-09	000	NO DATA	NA	ĄZ	AZ.				
Styrene	1.587E-06	4.116E-06	0N	0.2	Hepatotoxicity	IRIS 93	-	8E-06		2E-05	
Carbon Tetrachloride	2.442E-09	6.332E-09	ON	0.0007	Liver Lesions	IRIS 93	-	3E-06		9E-06	
Total									2E-05		4E-05

TABLE P-67 CANCER ESTEMATE - SURFACE WATER DERMAL FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Site 1, Former POL Facility, Alpena CRTC, Alpena, MI	ity, Alpena CRTC, Alp	ena, Mi						Adut	17.	Children	Total
	Adult CDI (malka-dav)	Child CDI (moka-dav)	CD! Adjusted for Absorption	SF* (mg/kg-day)^-1	Weight of Evidence	Type of Cancer	SF	Spedfic	Pathway Risk	Specific Risk	Pathway
Chemical	5.415-07		YES	2.90E-02	∢	Leukemia	IRIS 93	2E-08		. 2E-08	
bervere Antimony, Dissolved Bromodichloromethane	3.05E-10 4.51E-09		YES	NO EVIDENCE 6.33E-02 NO EVIDENCE	. B2	Liver	IRIS 93	3E-10 0E-00		3E-10 0E+00	
Obcomochioromethane Obenzofuran 4 A.Dicelometere	1.98E-10 1.42E-10 4.20E-09	1.52E-10 4.48E-09	YES	NO EVIDENCE 2.40E-02	O	Liver tumors	HEAST FY93	0E-400 1E-10 0E-400		1E-10 0E+00	
Styrene Carbon Tetrachloride	1.85E-07 7.45E-09	, ,-	YES	NO EVIDENCE 1.30E-01	882	Heptocelluar carcinomas		15-09		1E-09	
									2F-08		2E-08

*Adjusted from administered to absorbed dose using an oral absorption efficiency factor. Benzene =1,Bromodichormehane = 0.98, 1,4 DCB=1, CC4=.05,

TABLE P-68 CHRONIC HAZARDOUS INDEX ESTMATE - SURFACE WATER DERMAL FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncardinggeric Effects Ste 1, Former POL Facility, Alpena CRTC, Alpena, MI	ity, Alpena CRTC, Alpe	ena, MI									1
Chemical	Adut CDI (mg/kg-day)	Chid CDI (mg/kg-clay)	CDI Adjusted for Absorption	RfD* (mg/kg-cay)	Critical Effect	RfD Source	Modfying Factor	Adut Chemical- Specific Risk	Total Pathway Risk	Children Chemical- Sped fic Risk	Total Pathway Resk
Benzene	1.52E-06		YES	NODATA	₫ Z	AN	AN				
Antimorry, Dissolved	8.53E-10	1.52E-09	YES	2E-05	Reducedlifespan	IRIS 93		4E-05		8F-05	
Bromodichloromethane	1.26E-08		YES	0 0 196	Renal cytomegaly	IRIS 93	-	6E-07		15-06	
Dibromochloromethane	5.54E-10	•	YES	0.02	Hepatic lesions	IRIS 93	-	3E-08		5E-08	
Dibenzofuran	3.98E-10		YES	NO DATA	₹Z	AN	A Z				
1,4-Dichlorobenzene	1.18E-08		YES	NO DATA	Ϋ́N	AN N	V Z				
Styrene	5.17E-07	-	YES	0.01	Hepatotoxicity	IRIS 93	-	5E-05		9E-05	
Carbon Tetrachloride	2.08E-08	.,	YES	3.5E-05	Liver Lesions	IRIS 93	-	6E-04		1E-03	
Total									75 04		5

TABLE P-59 CANCER ESTIMATE - SOIL INHALATION FUTURE LAND USE SCENARIO - EXCAVATION WORKER

Carcinogenic Effects Site 1, Former POL Facility, Alpena CRTC, Alpena, MI

		Pathway	-						00+400
cavation Worker	Chemical-	Specific	Risk	COTHO		0E+00	00+40		
Ã		S.	Source						
		Type of	Cancer						
		Weight of	Evidence						
		SF	(ma/ka-dav)^-1	77	NO EVIDENCE	NO EVIDENCE		NO EVIDENCE	
	ċ	Adjusted for	Absorption	in the contract of	2	CN	2 :	ON N	
Site 1, Former PUL racility, Albana Chile, Albana, Mil	47.7	Adult	(App ref)	(mg/kg-day)	9 243F-05	10 11000	6.998E-U3	6.190E-05	
Site 1, Former POL				Chemical	Chlerabandona	Ciliotopeticerie	Ethylbenzene	Chamba	2012

^{*} Styrene classified as possible human carcinogen by IRAC. No slope factor has been adopted as of 12/08/93.

TABLE P-60 SUBCHRONIC HAZARDOUS INDEX ESTIMATE - SOIL INHALATION FUTURE LAND USE SCENARIO - EXCAVATION WORKER

Noncarcinogenic Effects Site 1, Former POL Facility, Alpena CRTC, Albena, MI

			Specific Pathway		E+00	E-01	E-02	2E+00
141	Excavation worker	Chem	Modifying Spe		1 24	1	- 1	
			RfD	Source	Heast FY93	Heast FY93	Heast FY93	
			Critical	Effect	Liver and Kidney	Developmental Toxicity	ONS effects	
		Subchronic	R	(mg/kg-dav)	0.05	0000	2.0	2.0
		Ido	Adjusted for	Absorption	CZ			
Site 1, rottler Por Facility, Alberta CKTC, Alberta, Mil		Actuit	IOS	(ma/km-day)	R ORZE-OS	0.001 5.00	6. 124E-02 F 446E 02	3.4105-02
ole i, rottlei rot				la cimento	Objection	Chichesterie	Emylbenzene	Styrene

^{*} RfD converted from corresponding RfC values.

Groundwater Solute Transport Model Data - Site 1

Theoretical Background

A two-dimensional Method of Characteristics (MOC) solute transport model (Konikow and Bredehoeft, 1989) was used for preliminary examination of contaminant migration within the shallow aquifer beneath the Alpena CRTC. The model is designed to calculate transient changes in solute concentrations within groundwater by simultaneously solving partial differential equations describing groundwater flow and transport and computes the change in a chemicals concentration over time. Changes in chemical concentrations over time are caused by the processes of convective transport, hydrodynamic dispersion, and mixing from fluid sources. This model couples the groundwater flow equation with solute transport equations.

The flow equation can be approximated by an implicit finite-difference equation. The model area is discretized into a rectangular grid with each square being a node. The finite difference equation is solved numerically for each node in the grid using an iterative alternating-direction implicit (ADI) procedure.

After the hydraulic head distribution is calculated, the velocity of groundwater flow can be computed at each node. The expression for average velocity of groundwater can be derived from Darcy's law. The groundwater velocity at each node is calculated utilizing an explicit finite-difference approximation of Darcy's law. The computer program uses an alternating-direction implicit procedure to solve a finite-difference approximation to the groundwater flow equation, and it uses the method of characteristics (MOC) to solve the solute transport equation. MOC uses a particle tracking procedure to represent convective transport and a two-step, explicit procedure to solve a finite-difference equation that describes the effects of hydrodynamic dispersion, fluid sources and sinks, and divergence of velocity.

A number of assumptions are inherent in the solute transport model:

- 1. Darcy's law is valid and hydraulic head gradients are the only significant driving mechanism for fluid flow.
- 2. The porosity and hydraulic conductivity of the aquifer are constant with time, and porosity is uniform in space.
- 3. Gradients of fluid density, viscosity, and temperature do not affect the velocity distribution.
- 4. No chemical reactions occur that affect the concentration of the solute, the fluid properties, or the aquifer-properties.
- 5. Ionic and molecular diffusion are negligible contributors to the total dispersive flux.
- 6. Vertical variations in head and concentrations are negligible.

7. The aquifer is homogeneous and isotropic with respect to the coefficients of longitudinal and transverse dispersivity.

Transport Model Input

A model grid of 32 columns by 19 rows with a 250 foot lateral spacing was used. Specified head cells were used at nodes corresponding to the South Branch of the Thunder Bay River, at nodes along the eastern boundary of the model grid area, and also at the sinkhole in the northeastern portion of the model. Groundwater elevations measured during September, 1993 were used as initial input into the transport model. Hydraulic conductivity values were calculated from slug tests performed at Alpena CRTC (Engineering Science, 1989; Earth Technology, 1994). Values of hydraulic conductivity range from 12 feet/day at Site 4 to 278 feet/day at Site 3.

Aquifer thickness values were obtained from drilling records of monitoring wells and soil borings obtained from the SI and RI field activities. Values listed are from logs in which the thickness of the shallow aquifer was clearly discernible, and ranged from 20 feet at Site 5 to 65 feet at Site 8. Transmissivity values were calculated by multiplying the calculated hydraulic conductivity values by the aquifer thickness. Transmissivity ranges from 420 ft²/day at TF4-MW3 to 15,290 ft²/day at CG3-MW5.

Monitoring of the discharge of springs into the sinkhole was performed during the SI (Engineering Science, 1990) and an estimate of approximately 18,000 gallons of water per day discharging into the sinkhole was calculated. In order to obtain a numerical estimate of discharge into the sinkhole for the model, MODFLOW (McDonald and Harbaugh, 1988), a 3- dimensional finite-difference groundwater flow model was used. MODFLOW was used because of its ability to simulate the effect of head-dependent groundwater flow into a groundwater sink (i.e. the sinkhole). This package was not available in MOC. The same model parameters and boundary conditions were used within MODFLOW as in MOC. Based upon hydraulic head data collected in September 1993, discharge from the shallow aquifer into the sinkhole is approximately 30,000 gallons per day.

The dispersivity of an aquifer in two dimensions is described by the longitudinal dispersion, the transverse dispersion and the ratio of the two (Fetter, 1993). As a contaminant plume moves further from its initial location within the aquifer by advection with the groundwater flow, the plume spreads. The spreading in the direction of groundwater flow is the longitudinal dispersion, the spreading in the direction perpendicular to the groundwater flow is known as the transverse dispersion (Fetter, 1993). The values of the dispersion coefficients are typically derived via bench scale tests, aquifer tests, or calibration of contaminant transport models. Since no data presently exists describing dispersivity within the shallow aquifer beneath the Alpena CRTC and insufficient data exists to allow for derivation of dispersivity via model calibration, moderate values of 100 feet for longitudinal dispersivity and 30 feet for transverse dispersivity were chosen (Gillham and Cherry, 1982). A more complete description of the model is given in the report, Preliminary Groundwater Modeling Effort, Earth Technology, August 1993.

Model Calibration:

The groundwater flow model was calibrated with respect to the September 1993 groundwater elevation measurements. Calibration of the groundwater flow model was accomplished by defining a set of parameters, boundary conditions, and stresses that produce simulated heads and fluxes that match field-measured values within a preestablished range of error (Anderson and Woessner, 1992). In order to match field measured values for hydraulic head as determined during September 1993, a few modifications were made to the preexisting groundwater flow model. These changes included updating the initial head array, modeling the sinkhole as a constant head cell to account for the large gradient changes in the vicinity of the sinkhole and including recharge to the model at a rate of 9 inches per year over the whole model area. By adjusting these parameters, an acceptable level of calibration was achieved. An acceptable level of calibration was defined as a root mean squared error (RMS) of less than 2 feet. The RMS, or the standard deviation is the average squared difference in measured and simulated heads and is given by the equation:

RMS=
$$\left[1/n\sum_{i=1}^{n} (h_m - h_s)_{i}^{2}\right]^{0.5}$$

n = number of wells
 h_m = measured head
 h₋ = model simulated head

Certain portions of the model may have values above the goal of 2 feet while others fall much below this value. The RMS represents the average error present in the model. The following provides a summary of the final calibrated heads for the flow model.

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
MP2MW1	10,25	679.69	676.68	3.01
MP2MW3	10,22	675.51	675.46	0.05
MP2MW4 5*	11,23	675.34	675.70	-0.36
MP2MW6	11,20	674.86	674.52	0.34
CG3MW1	6,24	677.38	676.69	0.69
CG3MW2	7,22 -	676.29	675.78	0.51
CG3MW3	9,23	676.50	675.98	0.52
CG3MW4_5*	8,23	676.41	676.08	0.33

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
CG3MW7	8,20	675.64	674.80	0.84
TF4MW1	7,9	667.23	668.83	-1.60
TF4MW2	8,10	659.61	664.22	-4.61
TF4MW3_4*	9,10	658.21	660.06	-1.85
SF5MW1	12,6	674.15	671.34	2.81
SF5MW2	14,5	675.32	672.67	2.65
SF5MW3_4*	13,6	676.46	671.64	4.82
SF5MW6	13,5	674.26	672.40	1.86
LF6MW1	14,9	672.1	670.40	1.70
LF6MW2	14,8	672.68	670.72	1.96
LF6MW3	14,10	671.93	670.21	1.72
LF6MW4	16,7	672.75	671.91	0.84
LF6MW5	15,7	673.07	671.56	1.51
LF6MW6	13,10	671.17	669.67	1.50
LF6MW8	15,9	673.12	670.78	2.34
HN8MW1	5,22	676.96	675.93	1.03
HN8MW2	6,19	675.31	674.50	0.81
HN8MW3_4*	7,21	676.01	675.35	0.66
RT9MW1	6,16	673.06	672.78	0.28
RT9MW2	7,14	668.21	670.81	-2.60
RT9MW3	9,15	670.72	671.26	-0.54
RT9MW4_5*	8,14	667.47	670.32	-2.85
RT9MW6	8,16	670.58	672.33	-1.75
S1MW2	13,26	677.39	676.63	0.76
S1MW3	13,27	677.15	676.98	0.17
S1MW11	15,24	675.72	675.67	0.05
S1MW12	16,25	674.55	675.94	-1.39

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
S1MW13	14,24	675.21	675.76	-0.55
S1MW14	14,25	673.92	676.14	-2.22
MP2MW2	12,24	675.57	675.96	-0.39

^{*} Indicates that more than one well is present in each node and an average value for hydraulic head was used.

Sum of Squared Residuals = 128.78/38 = 3.3891 Root Mean Squared Error = 1.84

It should also be noted that the model was calibrated with respect to the September 1993 water level data and should only be considered calibrated with respect to this data. More information on the water level fluctuation through time would be needed to perform a transient calibration. The model was not calibrated with respect to concentration data, but only with respect to hydraulic head.

Model Assumptions and Limitations

- * The model domain consisted only of the shallow unconfined aquifer (i.e. one layer).
- * The initial head data input to the transport model are results of measurements taken in September 1993.
- * Initial concentrations of compounds are results of the Round IV sampling event which was conducted from July to September 1993.
- * Hydraulic conductivity values are the result of slug tests performed in November, 1987 and September 1993.
- * The model was calibrated with respect to hydraulic head using September 1993 water level data and should only be considered calibrated with respect to September 1993 water level data.
- * The flow model was assumed to be at steady-state with respect to hydraulic head.

Site 1

The following compounds were present at Site 1: Benzene, Bromodichloromethane, Dibromochloromethane, 1,4- Dichlorobenzene, Styrene, Antimony, Carbon Tetrachloride, and Dibenzofuran. Concentrations input to the model are the result of groundwater sampling conducted during the July to September 1993 RI field events.

For Site 1, several scenarios were modeled. These included monitoring chemical concentrations through time along the South Branch of the Thunder Bay River and at Production Well #3 for chemicals observed in several wells at Site 1. Wells S1MW14, S1MW11, S1MW6, and Production Well #3 all had chemicals present above MDNR Type A or B cleanup criteria.

The following scenarios were modeled for S1MW14: Benzene at 11.5 ug/l, Bromodichloromethane at 0.78 ug/l, Dibromochlormethane at 2.1 ug/l, 1,4 - Dichlorobenzene at 0.08 ug/l, and Styrene at a concentration of 0.13 ug/l. Concentrations were input to the node corresponding to S1MW14 and concentrations through time were monitored along the South Branch of the Thunder Bay River.

Wells S1MW11 and S1MW6 contained elevated levels of Antimony at a concentration of 39.2 ug/l. This concentration was input to the model and the corresponding concentrations of Antimony through time were monitored along the South Branch of the Thunder Bay River.

Additionally, Carbon Tetrachloride and Dibenzofuran were present in Production Well #3 at concentrations of 1.2 ug/l and 2.5 ug/l, respectively. These values were input to the model and the concentrations were monitored through time along the South Branch of the Thunder Bay River.

Appendix Q: Site 2 Risk Assessment

Table Q-1A

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Groundwater - Site 2

MIANG, Alpena CRTC, Alpena, MI

ATI2	IOCATOR	SAMPLEID	MATRIX	ANALYTE	RESULT
PC-MP2	MW1	PC-MP2-MW1-GW4	GROUNDWATER	Arsenic, Dissolved	7.2000
PC-MP2	MW3	PC-MP2-MW3-GW4	GROUNDWATER	Arsenic, Dissolved	2.0000
PC-MP2	MW4	PC-MP2-MW4-GW4	GROUNDWATER	Arsenic, Dissolved	2.0000
PC-MP2	MW5	PC-MP2-MW5-GW4	GROUNDWATER	Arsenic, Dissolved	5.0500
PC-MP2	MW6	PC-MP2-MW6-GW4	GROUNDWATER	Arsenic, Dissolved	2.0000
PC-MP2	MW7	PC-MP2-MW7-GW4	GROUNDWATER	Arsenic, Dissolved	2.0000
PC-MP2	MW1	PC-MP2-MW1-GW4	GROUNDWATER	Tetrachloroethylene	0.1500
PC-MP2	MW2	PC-MP2-MW2-GW4	GROUNDWATER	Tetrachloroethylene	0.1500
PC-MP2	MW3	PC-MP2-MW3-GW4	GROUNDWATER	Tetrachloroethylene	0.1500
PC-MP2	MW4	PC-MP2-MW4-GW4	GROUNDWATER	Tetrachloroethylene	0.1500
PC-MP2	MW5	PC-MP2-MW5-GW4	GROUNDWATER	Tetrachloroethylene	0.1500
PC-MP2	MW6	PC-MP2-MW6-GW4	GROUNDWATER	Tetrachloroethylene	0.1200
PC-MP2	MW7	PC-MP2-MW7-GW4	GROUNDWATER	Tetrachloroethylene	6.3000

Table Q-2A
Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Soil - Site 2
MIANG, Alpena CRTC, Alpena, MI

RESULT	1.0000 1.3000	31.0000
РТН		
SAMPLE DEPTH RANGE	0.0000	0.0000
ANALYTE	Lead	Lead
MATRIX	SOIL	SOIL
SAMPLE ID	PC-MP2-SB10-SS00-01	PC-MP2-SB6-SS00-02
LOCATOR		SB6
SITE	PC-MP2	PC-MP2

TABLE Q-1 EXPOSURE ASSESSMENT PARAMETERS - INGESTION OF GROUNDWATER SIte 2, Motor Pool, Alpena CRTC, Alpena, Mi

PARAMETER	ADULT	СНІГД	
ngestion Rate (L/day) Exposure Frequency (days/year) Exposure Duration (years)	2 298 25 70	2 48 15 27	
bouy weight, ng Averaging Time Carcinogens Noncarcinogens	70 70 25	70 15	

TABLE Q-2 DAILY INTAKE - ADULT INGESTION OF SHALLOW GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

	Chemical	Ingestion	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Duration	Weight	Time	Rate
	(l/Bm)	(L/day)	(days/year)	(years)	(kg)	(days)	(mg/Kg-day)
Arsenic, Dissolved	4.613E-03	2	298	25	20	9125	1.076E-04
Tetrachloroethylene	2.737E-03	7	298	25	2	9125	6.384E-05

TABLE Q-3 DAILY INTAKE - CHILD
INGESTION OF SHALLOW GROUNDWATER
FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

Site 2, Motor Fool, A	Site 2, Motor Fool, Alpena Chile, Alpena Mi						
	Chemical	Ingestion	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Duration	Weight	Time	Rate
	(mg/kg)	(L/day)	(days/year)	(years)	(kg)	(days)	(mg/Kg-day)
Arsenic, Dissolved	4.613E-03	2	48	15	27	5475	4.494E-05
Tetrachloroethylene	2.737E-03	2	48	15	27	5475	2.666E-05

TABLE Q-4 DAILY INTAKE - ADULT INGESTION OF SHALLOW GROUNDWATER FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

	Cheminal	Ingestion	Exposure	Exposure	Body	Averaging	Intake
	Cigilical				MALTINE	Time	Rate
100	Concentration	Rate	Frequency	Duration	Meight	D	
Chemical		A 4. 00	factory over the	(veare)	(ka)	(davs)	(ma/Ka-day)
	(l/bm)	(L/Ody)	(days/year)	Carroll Control	18.		TC. C
	1040E 00	0	298	52	9	25550	3.843E-U3
Arsenic Dissolved	50-112-10-4	1		•	f	00000	りつものはつない
	50 3757 C	•	298	52	2	00007	4.200L-33
Tetrachloroethylene	Z.131E-U3	7					

TABLE Q-5 DALY INTAKE - CHILD INGESTION OF SHALLOW GROUNDWATER FUTURE LAND USE SCENARIO Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

	100	noitsean!	Evnostire	Exposure	Body	Averaging	Intake
	Chemical	Highestion			111-1-11	F	Date
	Concentration	Rate	Frequency	Duration	Weight	BILLIE	STRIL
Chemical		0.14-13	the many and the	(years)	(44)	(davs)	(ma/Ka-dav)
	(ma/ka)	(\cap\)	(days/year)	(CIDOA)	The same of the sa		-
	A 6426 A3	2	48	15	27	25550	9.6295-06
Arsenic, Dissolved	4.0 52.53	2 (2 \$	4	7.0	25550	5 712E-06
Tetrochloroethidene	2.737E-03	7	94	2	1.7		

TABLE Q-6 DALY INTAKE - ADULT
INGESTION OF GROUNDWATER DEEP AQUIFER PRODUCTION WELLS
FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

Chemical Ingestion Expos Chemical Concentration Rate Freque (mg/l) (mg/l) (L/day) (days/					
Concentration Rate (Indul) (Indul) 2 2 2		Exposure	•	veraging	Intake
(mg/l) (L/day) 2 9,000E-04	Rate Frequency	Duration	Weight	Time	Rate
9,000E-04		(years)	(kg)	(days)	(mg/Kg-day)
0		30	20	9125	2 0995-05
	7 298	67	2	2 4	
T. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.	298	25	0/	9125	Z.333E-U/

TABLE Q.7 DAILY INTAKE - CHILD INGESTION OF GROUNDWATER DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

(mg/Kg-day) 8.767E-06 9.741E-08 Averaging Time (days) 5475 5475 Body Weight (kg) 27 27 Exposure Duration (years) 15 Frequency (days/year) 48 48 Exposure Ingestion Rate (L/day) Chemical
Concentration
(mg/kg)
9,000E-04
1,000E-05 Arsenic, Dissolved Tetrachloroethylene Chemical

Q-8 DAILY INTAKE - ADULT INGESTION OF GROUNDWATER DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

	Chemical	Ingestion	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Duration	Weight	Time	Rate
	(l/bm)	(L/day)	(days/year)	(years)	(kg)	(days)	(mg/Kg-day)
Arsenic. Dissolved	9.000E-04	2	298	25	20	25550	7.498E-06
Tetrachioroethylene	1.000E-05	2	298	25	2	25550	8.331E-08

Q-9 DAILY INTAKE - CHILD INGESTION OF GROUNDWATER FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

	Chemical	Ingestion	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Duration	Weight	Time	Rate
	(mg/kg)	(L/day)	(days/year)	(years)	(kg)	(days)	(mg/Kg-day)
Arsenic, Dissolved	9.000E-04	2	48	15	27	25550	1.879E-06
Tetrachloroethylene	1.000E-05	7	48	15	27	25550	2.087E-08

TABLE Q-10 EXPOSURE ASSESSMENT PARAMETERS - INHALATION OF GROUNDWATER Site 2, Motor Pool, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	CHILD
Exposure Time (hours/day)	0.12	0.12
Inhalation Rate (cu m/hr)	9.0	9.0
Exposure Frequency (days/yr)	298	48
Exposure Duration (years)	25	15
Body Weight, Kg	20	27
Averaging Time		
Carcinogens	70	20
Noncarcinogens	25	15

TABLE Q-11 DALY INTAKE - ADULT INHALATION OF SHALLOW GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

	Chemical	Inhalation	Exposure	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(ma/cn m)	(cn m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	(mg/Kg-day)
Argenia Dissolved	0 000E+00	9.0	298	0.12	25	70	9125	0.000E+00
Tetrachloroethylene	2.585E-02	9.0	298	0.12	25	70	9125	2.171E-05

TABLE Q-12 DAILY INTAKE - CHILD INHALATION OF SHALLOW GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena Mi

	Chemical	Inhalation	Exposure	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Kate
	(ma/cn m)	(cn m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	(mg/Kg-day)
Arrento Dissolved	0 000 +00	0.600	48	0.12	15	27	5475	0.000E+00
Tetrachiorophic	2.585E-02	0.600	48	0.12	15	27	5475	9.065E-06

TABLE Q-13 DAILY INTAKE - ADULT INHALATION OF SHALLOW GROUNDWATER FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

Chemical Concentratic (mg/cu m)	Inhalation						
Concentration Rate (mg/cor mm) (cu m/hr) (con m/hr)		Exposerie L	Exposure	Exposure	Body	Averaging	Intake
(mg/cu m) (cu m/hr) (Rate	Frequency	Time	Duration	Weight	Time	Rate
12000	(cn m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	(mg/Kq-day)
Arsenic, Dissolved U.50 C.93	9.0	298	0.12	25	70	25550	0.000E+00
Tetrachloroethylene 2.585E-02 0.6 298	0.6	298	0.12	25	20	25550	7.753E-06

TABLE Q-14 DAILY INTAKE - CHILD INHALATION OF SHALLOW GROUNDWATER FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena Mi

	Chemical	Inhalation	Exposure	Exposure	Exposure	Body	Averaging	intake
Chemical	oncentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(mg/cn m)	(ca m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	(mg/Kg-day)
Arsenic, Dissolved	0.000E+00	0.600	48	0.12	15	27	25550	0.000E+00
Tetrachloroethylene	2.585E-02	0.600	48	0.12	15	27	25550	1.943E-06

TABLE Q-15 DALY INTAKE - ADULT INHALATION OF GROUNDWATER DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

	Chemical	Inhalation	Exposure	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(md/cn m)	(cn m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	(mg/Kg-day)
Arsenic Dissolved	0,000E+00	0.6	298	0.12	25	02	9125	0.000E+00
Tetrachloroethylene	9.446E-05	9.0	298	0.12	25	20	9125	7.932E-08

TABLE Q-16 DAILY INTAKE - CHILD INHALATION OF GROUNDWATER DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

	Chemical	Inhalation	Exposure	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(md/cn m)	(cn m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	(mg/Kg-day)
Arsenic, Dissolved	0	0.600	48	0.12	15	27	5475	0.000E+00
Tetrachloroethylene	9,446023E-05	0.600	48	0.12	15	27	5475	3.313E-08

TABLE Q-17 DAILY INTAKE - ADULT INHALATION OF GROUNDWATER DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena Mi

		A Company	ı					
Chemical	Concentration	innalation Rate	Exposure	Exposure	Exposure Duration	Sody Weight	Averaging	Intake
	(mg/cn m)	(cn m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	(mg/Kg-day)
Arsenic, Dissolved	0.000E+00	9.0	298	0.12	25	22	25550	0.000E+00
Tetrachloroethylene	9.446E-05	9.0	298	0.12	52	2	25550	2.833E-08

TABLE Q-18 DALY INTAKE - CHILD INHALATION OF GROUNDWATER DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena Mi

Chemical	Chemical Concentration	Inhalation Rate	Exposure Frequency	Exposure Time	Exposure Duration	Body Weight	Averaging	Intake Rate
	(mg/cn m)	(cn m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	(mg/Kg-day)
Arsenic, Dissolved	0.000E+00	0.600	48	0.12	15	27	25550	0.000E+00
Tetrachloroethylene	9.446E-05	0.600	48	0.12	15	27	25550	7.098E-09

TABLE Q-19 GROUNDWATER INHALATION MODEL CALCULATIONS Site 2, Motor Pool, Alpena CRTC, Alpena, MI

Chemicals	Chemical Concentration	Fraction Volatilized	Water Flow Rate	Showering Duration Period	Post Showering Duration Period (hr)	Bathroom Volume (cu m)	Snowering Maximum Contaminant Concn'n in Air (mg/cu m)	Showering MAX Contaminant Concor'n in Air (mg/cu m)
Arsenic, Dissolved Tetrachloroethylene	0.000E+00 2.737E-03	0.7	750	0.25	0.35	= =	0.000E+00 3.265E-02	0.000E+00 2.585E-02
Future land-use - Deep Aquifer Arsenic, Dissolved Tetrachloroethylene	0.000E+00 1.000E-05	0.7	750 750	0.25	0.35	==	0.000E+00 1.193E-04	0.000E+00 9.446E-05

TABLE Q-20 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH GROUNDWATER Site 2, Motor Pool, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	CHILD
Skin Surface Area Available for Contact (sq cm)	19400 13	13300
Exposure Time (hrs/day)	0.25	0.25
Dermal Permeability Constant	*	•
Exposure Frequency (days/year)	298	48
Exposure Duration (years)	25	15
Body Weight, Kg	70	27
Averaging Time		
Carcinogens	70	70
Noncarcinogens	25	15
Conversion Factor	0.001	

Chemical Specific Dermal Permeability Constant

Q-21 DAILY INTAKE - ADULT SHALLOW GROUNDWATER DERMAL CONTACT CURRENT LAND USE SCENARIO TABLE

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena Mi

Chemical		Chemical Concentration (mq/l)	Dermal Permeability (cm/hr)	Skin Surface Area (sq cm)	Exposure Frequency (days/year)	Exposure Time (hrs/day)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Conversion Factor (Vcu cm)	Intake Rate (mg/Kg-day)
Arsenic, Dissolved Tetrachloroethylene	(a) (b)	8 8	0.003	1	298 298	0.25	25 25	70	9125 9125	0.001	7.828E-07 6.192E-05

(a) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).
(b) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992a).

TABLE Q-22 DAILY INTAKE - CHILD SHALLOW GROUNDWATER DERMAL CONTACT CURRENT LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena Mi

Olle Z, Motor Poor, Alperia CATC, Alperia Mi	C, Alperia										
Chemical	0 00	- Lo	Dermal Permeability	Skin Surface Area	Exposure Frequency	Exposure Time	Exposure Duration	Body Weight	Averaging Time	Conversion Factor (Vou cm)	Intake Rate (mo/Ko-day)
		(I/BILI)	(cunul)	(ad citt)		(III s) day))cara	Rul	ladan.	1112	
Argenic Dissohved		8	0,003	13300		0.25	15	27	5475	0.001	2.241E-07
Tetrachloroethylene (b)		2.737E-03	0.4	13300	48	0.25	15	27	5475	0.001	1.773E-05

(a) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).
(b) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992a).

Q-23 DAILY INTAKE - ADULT SHALLOW GROUNDWATER DERMAL CONTACT CURRENT LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena Mi

Chemical		Chemical Concentration	Dermal Permeability	Skin Surface Area	Exposure Frequency	Exposure Time	Exposure Duration	Body Weight	Averaging Time	Conversion Factor	Intake Rate
		(Mg/l)	(cm/hr)	(sd cm)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(Non cm)	(mg/Kg-day)
Arsenic, Dissolved	(B)	4.613E-03	0.003		298	0.25	25	70	25550	0.001	2.796E-07
Tetrachloroethylene	(q)	2.737E-03	0.4		298	0.25	25	20	25550	0.001	2.211E-05

(a) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).
(b) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992a).

Q-24 DAILY INTAKE - CHILD SHALLOW GROUNDWATER DERMAL CONTACT CURRENT LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

Chemical		Chemical Concentration	Dermal Permeability	Skin Surface Area	Exposure Frequency	Exposure	Exposure Duration	Body	Averaging	Conversion	Intake
		(mg/l)	(cm/hr)		(days/year)	(hrs/day)	(years)	(kg)	(days)	(Non cm)	(mg/Kg-day)
Arsenic, Dissolved	(a)	4.613E-03	0.003		48	0.25	15	27	25550	0.001	4.803E-08
Tetrachloroethylene	(9)	2.737E-03	0.4		48	0.25	15	27	25550	0.001	3.799E-06

(a) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).

Q-25 DAILY INTAKE - ADULT GROUNDWATER DERMAL CONTACT DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO TABLE

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena Mi

Chemical	Chemical	Dermal	Skin	Exposure	Exposure	Exposure	Body	Averaging	Conversion	Intake
	Concentration	Permeability	Surface Area	Frequency	Time	Duration	Weight	Time	Factor	Rate
	(mg/l)	(cm/hr)	(sq.cm)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(Vcu cm)	(mg/Kg-day)
Arsenic, Dissolved (c) Tetrachloraethylene (a)	9.000E-04) 1.000E-05	0.001		298 298	0.25	25 25	70	9125 9125	0.001	3.091E-00 2.263E-07

(a) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a). (c) Experimentally measured PC value for water, used in the absence of chemical-specific experimental of predicted PC values (Tables 5-3 of U.S. EPA, 1992a).

Q-26 DAILY INTAKE - CHILD GROUNDWATER PRODUCTION WELLS FUTURE LAND USE SCENARIO TABLE

Noncarcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena Mi

Chemical	Chemical	Dermal	Skin	Exposure	Exposure	Exposure	Body	Averaging	Conversion	Intake
	Concentration	n Permeability	Surface Area	Frequency	Time	Duration	Weight	Time	Factor	Rate
	(md/l)	(cm/hr)	(sq cm)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(Vcu cm)	(mg/Kg-day)
Arsenic, Dissolved (c Tetrachloroethylene (a) 9.000E-04) 1.000E-05		ł	48	0.25	15	27	5475 5475	0.001	1.458E-08 6.478E-08

(a) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a). (c) Experimentally measured PC values (Tables 5-3 of U.S. EPA, 1992a).

TABLE Q-27 DAILY INTAKE - ADULT GROUNDWATER DERMAL CONTACT DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

emical		Chemical Concentration	Dermal Permeability	Skin Surface Area	Exposure Frequency	Exposure Time	Exposure Duration	Body Weight	Averaging	Conversion Factor	Intake
		(mg/l)	(cm/hr)	(ad cm)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(Vcu cm)	(mg/Kg-day)
rsenic, Dissolved	(0)	9.000E-04	0.001	19400	298	0.25	25	202	25550	0.001	1.818E-08
strachloroethylene	(B)	1.000E-05	0.4	19400	298	0.25	52	20	25550	0.001	8.081E-08

(a) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).

(c) Experimentally measured PC value for water, used in the absence of chemical-specific experimental of predicted PC values (Tables 5-3 of U.S. EPA, 1992a).

TABLE Q-28 DAILY INTAKE - CHILD GROUNDWATER DERMAL CONTACT DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 2, Motor Pool, Alpena CRTC, Alpena MI

Chemical	Chemical Concentration	Dermal Permeability	Skin Surface Area	Exposure Frequency	Exposure Time	Exposure Duration	Body Weight	Averaging Time	Conversion Factor	Intake
	(mg/J)	(cm/hr)	(mo bs)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(Non cm)	(mg/Kg-day)
Arsenic, Dissolved (c	3) 9.000E-0	4 0.001	13300	48	0.25	15	27	25550	0.001	3.123E-09
Tetrachloroethylene (a	1,000E-05	5 0.4	13300	48	0.25	15	27	25550	0.001	1.388E-08

(a) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).

(c) Experimentally measured PC value for water, used in the absence of chemical-specific experimental of predicted PC values (Tables 5-3 of U.S. EPA, 1992a).

TABLE 9.29 CANCER ESTIMATE . SHALLOW GROUNDWATER INGESTION FUTURE LAND USE SCENARIO . ADULTS AND CHILDREN

Cardinogenic Effects Site 2: Motor Pool, Alberra CRTC, Alberra, Mi

Med Tod Apar Chick								Ague	1	Calden	100
	Aduk	PIGO .	CDI Adjusted for	SF (mg/kg-day)^1	Weight of Evidence	Type of Carbor	Source	Spedic	Patriway Rask	Specific	Pathway
Chemical	(mg/kg-day)	(mg/kg-day)					100 03	75.05		2F-05	
Arseric, Dissolved Tetrachloroethylene (1)	3.843E-05 2.280E-05	9.629E-06 5.712E-06		1.8 0.051	A (1) B2 (2)	Uver	CAEPA	16.06		36-07	A
:									7E-05		2E-05

Converted from a unit risk of 10-05 upt. given in IRIS.
 Retrieved from California EPA, 1992b.

TABLE Q.30 CHRONIC HAZARDOUS INDEX ESTIMATE - SHALLOW GROUNDWATER INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

	The last of the la							Actif		Children	
								Chemical-	Total	Chemical-	Total
	Adult	Child	9	æ	Critical	P.P.	Modifying	Specific	Pathway	Specific	Pathway
	000	CD	Adjusted for	(mg/kg-day)	Effect	Source	Factor	78.82 **	*	R3 X8	F 5
hemical	(mg/kg-day)	(mg/kg-day)	Absorption								
seric, Dissolved	1.076E-04	4.494E-05	ON	0.0003	Keratosis	IRIS, 93	-	4E-01		1E-01	
strachloroethylene	6.384E-05	6.384E-05 2.666E-05	ON ON	0.01	Hepatoxaity	IRIS, 93	•	6E-03		3E-03	

TABLE Q.31 CANCER ESTIMATE - GROUNDWATER INGESTION DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

								Adult Chemical-	Total	Children Chemical-	Total
	Adult	₽ ō	Adjusted for	SF (mg/kg-day)^-1	Weight of Evidence	Type of Carcer	Source	Specific	Pathway Risk	Specific	Patrway Risk
hemica	(mg/kg-cay)	(Mg/kg-day)	3				00 014	45.05		20 10	
Arseric, Dissolved Tetrachloroethylene	7,498E-06 8,331E-08	1.879E-06 2.087E-08		1.8 0.051	A (1) B2 (2)	Skin, Lung Liver	IRIS, 93 CA EPA	1E-05		1E-09	
									1F-05		35-06

Converted from a unit risk of 10-05 ug/L given in IRIS.
 Retrieved from California EPA, 1992b.

TABLE Q.32 CHRONIC HAZARDOUS INDEX ESTMATE - GROUNDWATER INGESTION DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

								Adult	Į.	Children	ţ
	Adult	Child	CD	R _I O	Oritical	C)A	ModfAng	Specific	Pathway	Specific	Pathway
	CDI	G	Adjusted for	(mg/kg-day)	Effect	Source	Factor	78.9E	Fa sk	. A.	82
Chemical	(mg/kg-day)	(mg/kg-day)	Absorption								
vseric, Disadved	2.099E-05	2.099E-05 8.767E-06	ON	0,0003	Keratosis	IRIS, 93	-	7E-02		3E-02	
etrachioroethylene	2.333E-07	9.741E-08	ON	0.01	Hepatoxcity	IRIS, 93	-	2E-05		1E-05	

TABLE 0-13 CANCER ESTMATE - SHALLOW GROUNDWATER INHALATION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Site 2, Motor Pool, Apena CRTC, Apena, MI	CRTC, Alpera, MI							Adult		Children	-
	Adut	o del	CDI Adusted for (mg/kg-day)^1	SF ig/kg-day)^1	Weight of Evidence	Type of Cancer	Source	Spedfic	Pathway Risk	Specific	Pathway
nemical	(mayka-day)	ng/kg-day)	Absorption							00.70	
seric, Dissolved et action oethylene	0.000E+00 7.753E-06	0.000E+00 1.943E-06	0 0 0	0.0018	A (1) B2 (2)	Lung, skin Leukemia	IRIS 93 CA EPA	0E+00 1E-08		3E-09	

1) Irhalation slope factor converted from inhalation unit risk. 2) Retrieved from California EPA, 1992.

TABLE Q-34 CHRONG HAZARDOUS INDEX ESTRVATE - SHALLOW GROUNDWATER INHALATION
FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN
Norcarchogeric Effects
Site 2, Motor Pool, Alpera CRTC, Alpera, MI

IOLO PUOI, ALDERIA	, MOICH FOOD, APPEND CRIC, APPEND, MI										
	Adut CDi (mg/kg-day)	Child CDI (mg/kg-day)	CDI Adjusted for Absorption	RfD (mg/kg-day)	Critical Effect	RID So <i>u</i> ce	Modfying Factor	Adult Chemical- Spedfic Risk	Total Pathway Risk	Children Chemical- Spedific Risk	Total Pathway Risk
issolved	0.000E+00	0.000E+00		0.0003	NA	IRIS. 93	NA	0E+00		0E+00	
ane	2.171E-05	9.065E-06	ON	0.01	Y Z	IRIS, 93	NA	2E-03		9E-04	
									2F-03		9F-04

TABLE Q-36 CANCER ESTMATE - GROUNDWATER INHALATION DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

15 A (1) Lung, skin IRIS 93 0E-10 0.0018 B2 (2) Leukerria CA EPA 5E-11		Adult CDI	PICO.	CDi Adusted for (SF (mg/kg-day)^1	Weight of Exidence	Type of Cancer	Seurce	Adut Chemical- Spedfic Risk	Total Pathway Risk	Chemical- Spedific Risk	Total Pathway Risk
	Chemical Viseric, Dissolved Fetrachioroethylene	(mg/kg-day) 0.000E+00 2.833E-08	(mg/kg-cay) 0.000E+00 7.098E-09	NO	0.0018	A (1) B2 (2)	Ling, skin Letkema	IRIS 93 CA EPA	0E+00 5E-11		0E+00 1E-11	

1) Irhalation slope factor converted from irhalation unit risk. 2) Retrieved from Californa EPA, 1992.

TABLE Q.46 CHRONIC MAZARDOUS INDEX ESTMATE - GROUNDWATER INHALATION DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncardinogeric Effects Site 2, Motor Pool, Alpena	Noncardinogenic Effects Site 2, Motor Pool, Alpena CRTC, Alpena, MI										
								Adut Chemical-	Total	Children Chemical.	Total
	Adult	Child		RAD	Critical	RfD	ModfMng	Specific	Pathway	Specific	Pathway
	G	00		(mg/kg-day)	Effect	Source	Factor	18 AS	E E	AS SE	AS A
Chemical	(mg/kg-day)	(mg/kg-day)									
Arseric, Dissolved	0.000E+00	0.000E+00 0.000E+00	92	0.0003	NA	IRIS, 93	AZ.	0E+00		0E+00	
Tetrachloroethylene	7.932E-08	3.313E-08		0.01	AN	IRIS, 93	NA	8E-06		3E-06	
7-1-1											

TABLE Q-37 CANCER ESTIMATE - DERMAL CONTACT WITH SHALLOW GROUNDWATER FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Carchogenic Effects

Otto C, Misson 1 dell'alle alle alle alle alle alle alle a							Adult Chemical-	Total	Chemical-	Total
Adult	Child	CDI Adjusted for (my	SF • (mg/kg-day)^-1	Weight of Evidence	Type of Cancer	SF	Specific Risk	Pathway Risk	Specific Risk	Pathway Risk
ng/kg-day)	(mg/kg-day)	Absorption				60 0101	5E 07		95-08	
2.796E-07 2.211E-05	2.796E-07 4.803E-08 2.211E-05 3.799E-06	₹ ₹ Z Z	1.9 0.051	B2 ≽	X X	CA EPA	16-06		2E-07	
								2E-08		3E-07

Adjusted from administered to absorbed dose using an absorption efficiency of As0.95 (ATSDR, 90), PCE. 1.0 (ATSDR, 90)

TABLE Q-38 CHRONIC HAZARDOUS INDEX ESTIMATE - DERMAL CONTACT WITH SHALLOW GROUNDWATER FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncarcinogenic Effects Site 2, Motor Pool, Alpena CRTC, Alpena, Mi	its ena CRTC, Alpena, MI										
	44.4	1	ā	č		č		Adult Chemical-	Total	Chemical-	Total
	CDI	<u> </u>	Adjusted for	(ma/ka-dav)	Effect	Source	Modifying	Specific	Pathway	Specific	Pathway
hemical	(mg/kg-day)	(mg/kg-day) (mg/kg-day)								2	
rsenic, Dissolved	7.828E-07	2.241E-07		0.0003	NA.	IRIS, 93	1	3E-03		7E-04	
etrachloroethylene	6.192E-05	1.773E-05	YES	0.01	A A	IRIS, 93	-	6E-03		2E-03	
									9E-03	٠	3F-03

^{*} Adjusted from administered to absorbed dose using an absorption efficiency of As0.95 (ATSDR, 90), PCE 1.0 (ATSDR,90)

TABLE Q-39 CANCER ESTIMATE - DERMAL CONTACT WITH GROUNDWATER DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

	Site 2, Motor Pool, Alpena CRIC, Alpena, MI							Adult Chemical-	Total	Chemical-	Total
	Adult	CDI	CD! Adjusted for (i	CDI Adjusted for (mg/kg-day)^^-1	Weight of Evidence	Type of Cancer	Source	Specific Risk	Pathway Risk	Specific Risk	Pathway
hemical	(mg/kg-day)	(Mg/kg-day)	Absorbagn			414	IDIC 03	AE OR		8F-09	
Asenic, Dissolved Fetrachloroethylene	1.818E-08 8.081E-08	1,818E-08 3,123E-09 8,081E-08 1,388E-08	A A	0.051	₽ 29	V V	CA EPA	4E-09		7E-10	
									4E-08		7E-09

* Adjusted from administered to absorbed dose using an absorption efficiency of As0.95 (ATSDR, 90), PCE 1.0 (ATSDR,90)

TABLE Q-40 CHRONIC HAZARDOUS INDEX ESTIMATE - DERMAL CONTACT WITH GROUNDWATER DEEP AQUIFER PRODUCTION WELLS FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncardinogenic Effects Site 2, Motor Pool, Alpena	Noncarcinogenic Effects Site 2, Motor Pool, Alpena CRTC, Alpena, MI										
								Adult Chemical-	Total	Chemical-	Total
	Adult	Child	ā	RfD*	Critical	RfD	Modifying	Specific	Pathway	Specific	Pathway
	ō	CD	_	(mg/kg-day)	Effect	Source	Factor	Risk	Risk	Risk	Risk
Chemical	(mg/kg-day)	(mg/kg-day)									
Arsenic, Dissolved	5.091E-08	5.091E-08 1.458E-08	YES	0.0003	NA	IRIS, 93	-	2E-04		5E-05	
Tetrachloroethylene	2.263E-07	6.478E-08	YES	0.01	∀ Z	IRIS, 93	-	2E-05		90-39	
Total									25.04		SE OS

Groundwater Solute Transport Model Data - Site 2

Theoretical Background

A two-dimensional Method of Characteristics (MOC) solute transport model (Konikow and Bredehoeft, 1989) was used for preliminary examination of contaminant migration within the shallow aquifer beneath the Alpena CRTC. The model is designed to calculate transient changes in solute concentrations within groundwater by simultaneously solving partial differential equations describing groundwater flow and transport and computes the change in a chemicals concentration over time. Changes in chemical concentrations over time are caused by the processes of convective transport, hydrodynamic dispersion, and mixing from fluid sources. This model couples the groundwater flow equation with solute transport equations.

The flow equation can be approximated by an implicit finite-difference equation. The model area is discretized into a rectangular grid with each square being a node. The finite difference equation is solved numerically for each node in the grid using an iterative alternating-direction implicit (ADI) procedure.

After the hydraulic head distribution is calculated, the velocity of groundwater flow can be computed at each node. The expression for average velocity of groundwater can be derived from Darcy's law. The groundwater velocity at each node is calculated utilizing an explicit finite-difference approximation of Darcy's law. The computer program uses an alternating-direction implicit procedure to solve a finite-difference approximation to the groundwater flow equation, and it uses the method of characteristics (MOC) to solve the solute transport equation. MOC uses a particle tracking procedure to represent convective transport and a two-step, explicit procedure to solve a finite-difference equation that describes the effects of hydrodynamic dispersion, fluid sources and sinks, and divergence of velocity.

A number of assumptions are inherent in the solute transport model:

- Darcy's law is valid and hydraulic head gradients are the only significant driving mechanism for fluid flow.
- The porosity and hydraulic conductivity of the aquifer are constant with time, and porosity is uniform in space.
- 3. Gradients of fluid density, viscosity, and temperature do not affect the velocity distribution.
- 4. No chemical reactions occur that affect the concentration of the solute, the fluid properties, or the aquifer properties.
- 5. Ionic and molecular diffusion are negligible contributors to the total dispersive flux.

- 6. Vertical variations in head and concentrations are negligible.
- 7. The aquifer is homogeneous and isotropic with respect to the coefficients of longitudinal and transverse dispersivity.

Transport Model Input

A model grid of 32 columns by 19 rows with a 250 foot lateral spacing was used. Specified head cells were used at nodes corresponding to the South Branch of the Thunder Bay River, at nodes along the eastern boundary of the model grid area, and also at the sinkhole in the northeastern portion of the model. Groundwater elevations measured during September, 1993 were used as initial input into the transport model. Hydraulic conductivity values were calculated from slug tests performed at Alpena CRTC (Engineering Science, 1989; Earth Technology, 1994). Values of hydraulic conductivity range from 12 feet/day at Site 4 to 278 feet/day at Site 3.

Aquifer thickness values were obtained from drilling records of monitoring wells and soil borings obtained from the SI and RI field activities. Values listed are from logs in which the thickness of the shallow aquifer was clearly discernible, and ranged from 20 feet at Site 5 to 65 feet at Site 8. Transmissivity values were calculated by multiplying the calculated hydraulic conductivity values by the aquifer thickness. Transmissivity ranges from 420 ft²/day at TF4-MW3 to 15,290 ft²/day at CG3-MW5.

Monitoring of the discharge of springs into the sinkhole was performed during the SI (Engineering Science, 1990) and an estimate of approximately 18,000 gallons of water per day discharging into the sinkhole was calculated. In order to obtain a numerical estimate of discharge into the sinkhole for the model, MODFLOW (McDonald and Harbaugh, 1988), a 3- dimensional finite-difference groundwater flow model was used. MODFLOW was used because of its ability to simulate the effect of head-dependent groundwater flow into a groundwater sink (i.e. the sinkhole). This package was not available in MOC. The same model parameters and boundary conditions were used within MODFLOW as in MOC. Based upon hydraulic head data collected in September 1993, discharge from the shallow aquifer into the sinkhole is approximately 30,000 gallons per day.

The dispersivity of an aquifer in two dimensions is described by the longitudinal dispersion, the transverse dispersion and the ratio of the two (Fetter, 1993). As a contaminant plume moves further from its initial location within the aquifer by advection with the groundwater flow, the plume spreads. The spreading in the direction of groundwater flow is the longitudinal dispersion, the spreading in the direction perpendicular to the groundwater flow is known as the transverse dispersion (Fetter, 1993). The values of the dispersion coefficients are typically derived via bench scale tests, aquifer tests, or calibration of contaminant transport models. Since no data presently exists describing dispersivity within the shallow aquifer beneath the Alpena CRTC and insufficient data exists to allow for derivation of dispersivity via model calibration, moderate values of 100 feet for longitudinal dispersivity and 30 feet for transverse dispersivity were chosen (Gillham and Cherry, 1982). A more complete description of the model is given in the report,

Preliminary Groundwater Modeling Effort, Earth Technology, August 1993.

Model Calibration:

The groundwater flow model was calibrated with respect to the September 1993 groundwater elevation measurements. Calibration of the groundwater flow model was accomplished by defining a set of parameters, boundary conditions, and stresses that produce simulated heads and fluxes that match field-measured values within a preestablished range of error (Anderson and Woessner, 1992). In order to match field measured values for hydraulic head as determined during September 1993, a few modifications were made to the preexisting groundwater flow model. These changes included updating the initial head array, modeling the sinkhole as a constant head cell to account for the large gradient changes in the vicinity of the sinkhole and including recharge to the model at a rate of 9 inches per year over the whole model area. By adjusting these parameters, an acceptable level of calibration was achieved. An acceptable level of calibration was defined as a root mean squared error (RMS) of less than 2 feet. The RMS, or the standard deviation is the average squared difference in measured and simulated heads and is given by the equation:

RMS=
$$[1/n\sum_{i=1}^{n} (h_m - h_s)_{i}^{2}]^{0.5}$$

n = number of wells $h_m = measured head$ $h_m = model simulated head$

Certain portions of the model may have values above the goal of 2 feet while others fall much below this value. The RMS represents the average error present in the model. The following provides a summary of the final calibrated heads for the flow model.

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
MP2MW1	10,25	679.69	676.68	3.01
MP2MW3	10,22	675.51	675.46	0.05
MP2MW4 5*	11,23	675.34	675.70	-0.36
MP2MW6	11,20	674.86	674.52	0.34
CG3MW1	6,24	677.38	676.69	0.69
CG3MW2	7,22	676.29	675.78	0.51
CG3MW3	9,23	676.50	675.98	0.52

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
CG3MW4_5*	8,23	676.41	676.08	0.33
CG3MW7	8,20	675.64	674.80	0.84
TF4MW1	7,9	667.23	668.83	-1.60
TF4MW2	8,10	659.61	664.22	-4.61
TF4MW3_4*	9,10	658.21	660.06	-1.85
SF5MW1	12,6	674.15	671.34	2.81
SF5MW2	14,5	675.32	672.67	2.65
SF5MW3_4*	13,6	676.46	671.64	4.82
SF5MW6	13,5	674.26	672.40	1.86
LF6MW1	14,9	672.1	670.40	1.70
LF6MW2	14,8	672.68	670.72	1.96
LF6MW3	14,10	671.93	670.21	1.72
LF6MW4	16,7	672.75	671.91	0.84
LF6MW5	15,7	673.07	671.56	1.51
LF6MW6	13,10	671.17	669.67	1.50
LF6MW8	15,9	673.12	670.78	2.34
HN8MW1	5,22	676.96	675.93	1.03
HN8MW2	6,19	675.31	674.50	0.81
HN8MW3_4*	7,21	676.01	675.35	0.66
RT9MW1	6,16	673.06	672.78	0.28
RT9MW2	7,14	668.21	670.81	-2.60
RT9MW3	9,15	670.72	671.26	-0.54
RT9MW4_5*	8,14	667.47	670.32	-2.85
RT9MW6	8,16	670.58	672.33	-1.75
S1MW2	13,26	677.39	676.63	0.76
S1MW3	13,27	677.15	676.98	0.17

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
S1MW11	15,24	675.72	675.67	0.05
S1MW12	16,25	674.55	675.94	-1.39
S1MW13	14,24	675.21	675.76	-0.55
S1MW14	14,25	673.92	676.14	-2.22
MP2MW2	12,24	675.57	675.96	-0.39

^{*} Indicates that more than one well is present in each node and an average value for hydraulic head was used.

Sum of Squared Residuals = 128.78/38 = 3.3891 Root Mean Squared Error = 1.84

It should also be noted that the model was calibrated with respect to the September 1993 water level data and should only be considered calibrated with respect to this data. More information on the water level fluctuation through time would be needed to perform a transient calibration. The model was not calibrated with respect to concentration data, but only with respect to hydraulic head.

Model Assumptions and Limitations

- * The model domain consisted only of the shallow unconfined aquifer (i.e. one layer).
- * The initial head data input to the transport model are results of measurements taken in September 1993.
- * Initial concentrations of compounds are results of the Round IV sampling event which was conducted from July to September 1993.
- * Hydraulic conductivity values are the result of slug tests performed in November, 1987 and September 1993.
- * The model was calibrated with respect to hydraulic head using September 1993 water level data and should only be considered calibrated with respect to September 1993 water level data.
- * The flow model was assumed to be at steady-state with respect to hydraulic head.

Site 2

PCE was detected in two wells at Site 2. Wells MP2MW7 and MP2MW1 contained concentrations of PCE of 6.3 and 7.2 ug/l, respectively. These concentrations were input to the model at their respective nodes and the concentrations were monitored at Production Well #2 and at the sinkhole with respect to time.

Appendix R: Site 3 Risk Assessment

Table R-1A

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Soils and Subsoils - Site 3

MIANG, Alpena CRTC, Alpena, MI

	SAMPLEID	Z Z Z	ANALTE	RANGE	-	
	DC.CG3.SB11.SS00-02	SOIL	Benzo(a)anthracene	0.0000	2.0000	230.0000
	C-CG3-SB12-SS00	SOIL	Benzo(a)anthracene	0.000	2.0000	170.0000
	PC-CG3-SB13-SS00-02	SOIL	Benzo(a)anthracene	0.0000	2.0000	170.0000
	PC-CG3-SB11-SS04-06	SUBSOIL	Benzo(a)anthracene	4.0000	6.0000	1/0.0000
	PC-CG3-SB11-SS10-12	SUBSOIL	Benzo(a)anthracene	10.0000	12.0000	1/0.0000
	PC-CG3-SB12-SS04-06	SUBSOIL	Benzo(a)anthracene	4.0000	6.0000	1/0.0000
	PC-CG3-SB12-SS10-12	SUBSOIL	Benzo(a)anthracene	10.0000	12.0000	00000/1
SB13	PC-CG3-SB13-SS04-06	SUBSOIL	Benzo(a)anthracene	4.0000	6.0000	170.0000
	PC-CG3-SB13-SS10-12	SUBSOIL	Benzo(a)anthracene	10.0000	12.0000	1/0.0000
200.0	PC-CG3-SB13-SS08-10	SUBSOIL	Benzo(a)anthracene	8.0000	10.0000	520.0000
١.	PC-CG3-SB11-SS00-02	SOIL	Benzo(a)pyrene	0.0000	2.0000	170.0000
200	PC-CG3-SB12-SS00-02	SOIL	Benzo(a)pyrene	0.0000	2.0000	170.0000
2012	DC CC3 SB13-SS00-07		Benzo(a)pyrene	0.0000	2.0000	170.0000
5515	TC-CG2-5E13-5GG-5E	I I I I I I I	Benzo(a)pyrene	4.0000	6.0000	170.0000
5811	PC-CG3-5B11-5CG4-5C		Benzo(a)byrene	10.0000	12.0000	170.0000
0011	PC-CG3-SB17-SS04-06	SUBSOIL	Benzo(a)pyrene	4.0000	6.0000	170.0000
2012	PC-CG3-SB12-SS10-12	SUBSOIL	Benzo(a)pyrene	10.0000	12.0000	170.0000
2012	PC-CG3-SB13-SS04-06	SUBSOIL	Benzo(a)pyrene	4.0000	6.0000	170.0000
0813 0813	PC-CG3-SB13-SS10-12	SUBSOIL	Benzo(a)pyrene	10.0000	12.0000	170.0000
5 5 5	DC-CG3-SB13-SS08-10	SUBSOIL	Benzo(a)pyrene	8.0000	10.0000	350.0000
<u>.</u> 2	PC-CG3-6B11-8800-02	SOIL	Benzo(b)fluoranthene	0.0000	2.0000	300.0000
001	PC-CG3-GB11-GGG GE	SOIL	Benzo(b)fluoranthene	0.0000	2.0000	170.0000
7 (DC CC3 CB12 CCC0 CI	C	Benzo(b)fluoranthene	0.0000	2.0000	170.0000
5813	DO 003 0B11-0004-06	SIBSOIL	Benzo(b)fluoranthene	4.0000	6.0000	170.000
0011	PC-CG3-5B11-6651-55	SIBSOIL	Benzo(b)fluoranthene	10.0000	12.0000	170.0000
1 200	20.000.000.000.000	II COMI IO	Renzo(h)fl.joranthene	4,0000	0000.9	170.0000
SB12	PC-CG3-SB12-SS04-08	100000	Benzo(h)flioranthene	10 0000	12.0000	170.0000
B12	PC-CG3-SB12-SS10-12	SOBSOIL	Del (20(b)) dol al la lei le	0000	0000	170 0000
B13	PC-CG3-SB13-SS04-06	SUBSOIL	Benzo(b)filloranmene	4.0000	7.000	170.000
SB13	PC-CG3-SB13-SS10-12	SUBSOIL	Benzo(b)fluoranthene	10.000	12.0000	720.000
SB13	PC-CG3-SB13-SS08-10	SUBSOIL	Benzo(b)fluoranthene	8.0000	10.0000	70.000
SB11	PC-CG3-SB11-SS00-02	SOIL	Benzo(k)fluoranthene	0.0000	2.0000	300.000
	PC-CG3-SB12-SS00-02	SOIL	Benzo(k)fluoranthene	0.0000	2.0000	1/0.000

Table R-1A (continued)

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Soils and Subsoils - Site 3

MIANG, Alpena CRTC, Alpena, MI

<u> </u>	LOCATOR	SAMPLEID	MATRIX	ANALYTE	SAMPLE DEPTH RANGE	HT.	RESULT
PC-CG3	SB13	PC-CG3-SB13-SS00-02	SOIL	Benzo(k)fluoranthene	0.0000	2.0000	170,0000
PC-CG3	SB11	PC-CG3-SB11-SS04-06	SUBSOIL	Benzo(k)fluoranthene	4.0000	00000	170,0000
PC-CG3	SB11	PC-CG3-SB11-SS10-12	SUBSOIL	Benzo(k)fluoranthene	10.0000	12.0000	170,0000
PC-CG3	SB12	PC-CG3-SB12-SS04-06	SUBSOIL	Benzo(k)fluoranthene	4.0000	6.0000	170,0000
Pc-cg3	SB12	PC-CG3-SB12-SS10-12	SUBSOIL	Benzo(k)fluoranthene	10.0000	12.0000	170,0000
PC-CG3	SB13	PC-CG3-SB13-SS04-06	SUBSOIL	Benzo(k)fluoranthene	4.0000	6,0000	170,0000
PC-CG3	SB13	PC-CG3-SB13-SS10-12	SUBSOIL	Benzo(k)fluoranthene	10.0000	12.0000	170,0000
PC-CG3	SB13	PC-CG3-SB13-SS08-10	SUBSOIL	Benzo(k)fluoranthene	8.0000	10.0000	770.0000
PC-CG3	SB11	PC-CG3-SB11-SS00-02	SOIL	Chrysene	0.0000	2.0000	210.0000
PC-CG3	SB12	PC-CG3-SB12-SS00-02	SOIL	Chrysene	0.0000	2.0000	170.0000
PC-CG3	SB13	PC-CG3-SB13-SS00-02	SOIL	Chrysene	0.0000	2.0000	170.0000
PC-CG3	SB11	PC-CG3-SB11-SS04-06	SUBSOIL	Chrysene	4.0000	6.0000	170.0000
Pc-cg3	SB11	PC-CG3-SB11-SS10-12	SUBSOIL	Chrysene	10.0000	12.0000	170.0000
PC-CG3	SB12	PC-CG3-SB12-SS04-06	SUBSOIL	Chrysene	4.0000	6.0000	170.0000
PC-CG3	SB12	PC-CG3-SB12-SS10-12	SUBSOIL	Chrysene	10.0000	12.0000	170.0000
PC-CG3	SB13	PC-CG3-SB13-SS04-06	SUBSOIL	Chrysene	4.0000	6.0000	170.0000
PC-CG3	SB13	PC-CG3-SB13-SS10-12	SUBSOIL	Chrysene	10.0000	12.0000	170,0000
PC-CG3	SB13	PC-CG3-SB13-SS08-10	SUBSOIL	Chrysene	8.0000	10.0000	530,0000
Pc-cg3	SB11	PC-CG3-SB11-SS00-02	SOIL	Dibenzofuran	0.0000	2.0000	173.0000
Pc-cg3	SB12	PC-CG3-SB12-SS00-02	SOIL	Dibenzofuran	0.0000	2.0000	170.0000
Pc-cg3	SB13	PC-CG3-SB13-SS00-02	SOIL	Dibenzofuran	0.0000	2.0000	170.0000
Pc-cg3	SB11	PC-CG3-SB11-SS04-06	SUBSOIL	Dibenzofuran	4.0000	6.0000	170.0000
PC-CG3	SB11	PC-CG3-SB11-SS10-12	SUBSOIL	Dibenzofuran	10.0000	12.0000	170.0000
PC-CG3	SB12	PC-CG3-SB12-SS04-06	SUBSOIL	Dibenzofuran	4.0000	6.0000	170.0000
PC-CG3	SB12	PC-CG3-SB12-SS10-12	SUBSOIL	Dibenzofuran	10.0000	12.0000	170.0000
PC-CG3	SB13	PC-CG3-SB13-SS04-06	SUBSOIL	Dibenzofuran	4.0000	6.0000	170.0000
PC-CG3	SB13	PC-CG3-SB13-SS10-12	SUBSOIL	Dibenzofuran	10.0000	12.0000	170.0000
Pc-cg3	SB13	PC-CG3-SB13-SS08-10	SUBSOIL	Dibenzofuran	8.0000	10.0000	150.0000
PC-CG3	SB11	PC-CG3-SB11-SS00-02	SOIL	Indeno(1,2,3-c,d)pyrene	0.000	2.0000	165.0000
PC-CG3	SB12	PC-CG3-SB12-SS00-02	SOIL	Indeno(1,2,3-c,d)pyrene	0.0000	2.0000	170.0000
PC-CG3		PC-CG3-SB13-SS00-02	SOIL	Indeno(1,2,3-c,d)pyrene	0.0000	2.0000	170.0000
PC-CG3	SB11	PC-CG3-SB11-SS04-06	SUBSOIL	Indeno(1,2,3-c,d)pyrene	4.0000	6.0000	170.0000

Table R-1A (continued)

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Soils and Subsoils - Site 3

MIANG, Alpena CRTC, Alpena, MI

SITE	LOCATOR	SAMPLEID	MATRIX	ANALYTE	SAMPLE DEPTH RANGE	RESULT
					ľ	470,000
טר רבי	SB11	PC-CG3-SB11-SS10-12	SUBSOIL	Indeno(1,2,3-c,d)pyrene	10.000	70.000
		DC-CG3-SB12-SS04-06	SUBSOIL	Indeno(1,2,3-c,d)pyrene	4.0000 6.0000	170.0000
25-52	2012	TO-000-001 50		Indepo(123-c d)nyrene	10 0000 12.0000	170.0000
PO-063	SB12	PC-CG3-SB1Z-SS10-1Z	SOBSOIL	21 12 16 16 17 2 17 12 12 12 12 12 12 12 12 12 12 12 12 12		470 000
500,00	SB13	PC-CG3-SB13-SS04-06	SUBSOIL	Indeno(1,2,3-c,d)pyrene		70.000
	0 00	DC-CG3-SB13-SS10-12	SUBSOIL	Indeno(1,2,3-c,d)pyrene	10.0000 12.0000	170.0000
25.57	200	10 000 0740 000 04		Indeno(1.2.3-c.d)nyrene	8 0000 10.0000	190.0000
PC-063	SB13	01-0000-51 40-550-10	SOBSOIL	11 12 12 14 12 15 15 15 15 15 15 15 15 15 15 15 15 15		205 0000
PC-093	SB11	PC-CG3-SB11-SS00-02	SOIL	Phenanthrene		200.000
2000	CB12	PC-CG3-SB12-SS00-02	SOIL	Phenanthrene	0.0000	0000.0/L
500	200	20 000 619 600 00	0	Dhenanthrene	0.0000	170.0000
PC-CG3	SB13	PC-0000-01 00-000-04	SOL			170 000
PC-CG3	SB11	PC-CG3-SB11-SS04-06	SUBSOIL	Phenanthrene	•	10.000
	CB11	PC-CG3-SB11-SS10-12	SUBSOIL	Phenanthrene	10.0000	1/0.000
500		DC_CC3_CR12_SSD4-06	SUBSOIL	Phenanthrene	4.0000 6.0000	170.0000
20-0-1	7 90	07 07 00 07 00 00		O'Constant	10 000 11	170.0000
PO-003	SB12	PC-CG3-SB1Z-SS10-1Z	SOBSOL			_
	SB13	PC-CG3-SB13-SS04-06	SUBSOIL	Phenanthrene	4.0000	
	2,00	PC-CG3-SB13-SS10-12	SUBSOIL	Phenanthrene	10.0000 12.0000	170.0000
200	200	2000 CD3 CD43 CC08 40	I DOUBLE	Dhenanthrene	8,0000 10,0000	1500.0000
PC-CG3	SB13	PC-C63-5013-5500-10	SOCIE			

Table R-2A
Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Surface Soils - Site 3
MIANG, Alpena CRTC, Alpena, MI

SITE	LOCATOR	SAMPLEID	MATRIX	ANALYTE	SAMPLE DEPTH	H	RESULT
					RANGE		
PC-CG3	SB11	PC-CG3-SB11-SS00-02	SOIL	Benzo(a)anthracene	0.0000	2.0000	230.0000
PC-CG3	SB12	PC-CG3-SB12-SS00-02	SOIL	Benzo(a)anthracene	0.0000	2.0000	170.0000
PC-CG3	SB13	PC-CG3-SB13-SS00-02	SOIL	Benzo(a)anthracene	0.000	2.0000	170,0000
PC-CG3	SB11	PC-CG3-SB11-SS00-02	SOIL	Benzo(b)fluoranthene	0.0000	2.0000	300,0000
PC-CG3	SB12	PC-CG3-SB12-SS00-02	SOIL	Benzo(b)fluoranthene	0.0000	2.0000	170.0000
PC-CG3	SB13	PC-CG3-SB13-SS00-02	SOIL	Benzo(b)fluoranthene	0.0000	2.0000	170.0000
PC-CG3	SB11	PC-CG3-SB11-SS00-02	SOIL	Benzo(k)fluoranthene	0.0000	2.0000	300.0000
PC-CG3	SB12	PC-CG3-SB12-SS00-02	SOIL	Benzo(k)fluoranthene	0.0000	2.0000	170.0000
PC-CG3	SB13	PC-CG3-SB13-SS00-02	SOIL	Benzo(k)fluoranthene	0.0000	2.0000	170.0000
PC-CG3	SB11	PC-CG3-SB11-SS00-02	SOIL	Chrysene	0.0000	2.0000	210.0000
PC-CG3	SB12	PC-CG3-SB12-SS00-02	SOIL	Chrysene	0.0000	2.0000	170.0000
PC-CG3	SB13	PC-CG3-SB13-SS00-02	SOIL	Chrysene	0.000	2.0000	170.0000

TABLE R-1 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH SOILS SILE 3, Former County Garage, Alpena CRTC, Alpena, MI

	EXCAVATION	
PAKAMETEK		
Skin Surface Area Available for Contact (cm^2/day)	3120	
Soil to Skin Adherence Factor (mg/cm^2)	2.77	
Absorption Factor, Unitless		
Metals	0.01	
Organics	0.25	
Exposure Eartor (days/vear)	250	
Exposure Direction (veer)	0.08	
Body Weight (kilograms)	70	
Conversion Factor	1E-06	
Averaging Time years		
Sales	70	
Noncapcionagens	0.08	

Recreational Adult Assumes that the adult works at the recreational facility 250 days /year and participates in recreational activites another 48 days per year

TABLE R-2 DAILY INTAKE - EXCAVATION WORKER
DERMAL CONTACT WITH SOILS
FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

Noncarcinogenic Effect Exposure Assessment

	Absorbed Dose (mg/kg-day) 4.672E-06 3.638E-06 1.181E-05
	Average Time (days) 29.2 29.2 29.2
	Body Weight (kg) 70 70 70
	Exposure Duration (Years) 0.08 0.08
	Exposure Frequency (days/year) 250 250 250
	Absorption Factor (unitless) 0.25 0.25
	Soil to Skin Adherence (mg/cm^2) 2.77 2.77 2.77
	Available Skin Surface (cm^2Z/day) 3120 3120 3120
	Conversion Factor (kg/mg) 1.00E-06 1.00E-06
Site 3, Former County Garage, Alpena CRTC, Alpena, MI	Chemical Concentration (mg/kg) (m2/kg) (m2/kg) (m2/kg) (m2/kg) (m2/kg) (m2/kg) (m2/kg)
Site 3, Former Coun	Chemical Benzo(a)pyrene Dibenzo(ran Phenanthrene

TABLE

R-3 DAILY INTAKE - EXCAVATION WORKER DERMAL CONTACT WITH SOILS FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

Carcinogenic Effect Exposure Assessment Site 3, Former County Garage, Alpena CRTC, Alpena, MI

Absorbed Dose (mg/kg-day) 5.339E-09 4.180E-09 1.350E-08 Body Weight · (kg) 70 70 70 Exposure
Duration
(years)
0.08
0.08 Exposure Frequency (days/year) 250 250 250 Absorption Factor (unitless) 0.25 0.25 Skin Adherence (mg/cm^2) 2.77 2.77 2.77 Soil to Available Skin Surface (cm^2/day) 3120 3120 Conversion Factor (kg/mg) 1.0E-06 1.0E-06 Chemical Concentration (mg/kg) 2.210E-01 1.730E-01 5.588E-01 Benzo(a)pyrene Dibenzofuran Phenanthrene Chemical

TABLE R.4 EXPOSURE ASSESSMENT PARAMETERS - SOIL INGESTION Site 3, Former County Garage, Alpena CRTC, Alpena, MI

PARAMETER	EXCAVATION WORKER	
Indestion Rate (molday)	007	
Fraction indested from	OG:	
Contaminated Sources (unitless)	-	
Exposure Frequency (days/year)	250	
Exposure Duration (years)	800	
Body Weight (kitograms)	20	
Conversion Factor	1E-06	
Averaging Time, years		
Carcinogens	02	
Noncarcinogens	0.00	

TABLE R-5 DAILY INTAKE SOIL INGESTION FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

Noncarcinogenic Effect Exposure Assessment Site 3, Former County Garage, Alpena CRTC, Alpena, MI

Concentration Rate (mg/day) (mg/day) (unitess) (days/vear) (vears) (kg) (days) (lime 1 yyrere 0.20994 1E-06 480 1 250 0.08 70 29.2 rene 0.55879078 1E-06 480 1 250 0.08 70 29.2	Concentration Rate Ingestor Rate Indestor Rate Ingestor Concentration Concentration		Chemical	Conversion		Fraction	Exposure	Exposure	Body	Average	
(mg/kg) (mg/kg) (mg/kg) (mg/kgy) (mg/kgy) (kg) (kg)	Te (mg/day) (mg/day) (miless) (days/vear) (years) (kg) (days) (colored to 0.20994 TE-06 480 TE-06 0.08 70 29.2 CE 0.05879078 TE-06 480 TE-06 0.08 70 29.2	Chemical	Concentration	Rate	Ingestion Rate	Ingested	Frequency	Duration	Weight	Time	Intake Rate
Te 0.22994 TE-06 480 T 250 0.08 70 29.2 1 250 0.08 T 29.2 2 29.2 1 250 0.08 T 29.2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Te 0.22094 1E-06 480 1 250 0.08 70 29.2 0.173 1E-06 480 1 250 0.08 70 29.2 0.55879078 1E-06 480 1 250 0.08 70 29.2		(mg/kg)		(mg/day)	(unitless)	(days/year)	(years)	(kg)	(days)	(mg/kg-day)
0.173 1E-06 480 1 250 0.08 70 29.2 0.55879078 1E-06 480 1 250 0.08 70 29.2	0.173 1E-06 480 1 250 0.08 70 29.2 0.55879078 1E-06 480 1 250 0.08 70 29.2	Benzo(a)pyrene	0.220994	1E-06	480		250	0.08	70	29.2	1.038E-06
0.55899078 1E-06 480 1 250 0.08 70 29.2	0.55879078 1E-06 480 1 250 0.08 70 29.2	Dibenzofuran	0.173	1E-06	480	-	250	0.08	70	29.2	8 125E-07
		henanthrene	0.55879078	1E-06	480	-	250	0.08	70	29.2	2.624E-06

TABLE R-6 DAILY INTAKE SOIL INGESTION FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

Carcinogenic Effect Exposure Assessment Site 3, Former County Garage, Alpena CRTC, Alpena, MI

									ı
Chemical	Chemical Concentration (mg/kg)	Conversion Rate	Ingestion Rate (mg/day)	Fraction Ingested (unifless)	Exposure Frequency (days/year)	Exposure Duration (vears)	Body Weight	Average Time (days)	
Benzo(a)pyrene Dibenzofuran Phenanthrene	0.220994 0.173 0.55879078	1E-06 1E-06 1E-06	480 480 480		250 250 250 250	0.08 0.08 0.08	07 07	25550 25550 25550 25550	

Intake Rate (mg/kg-day) 1.186E-09 9.286E-10 2.999E-09

TABLE R-7 EXPOSURE ASSESSMENT PARAMETERS - SOIL INHALATION Site 3, Former County Garage, Alpena CRTC, Alpena, MI

	EXCAVATION
PARAMETER	WORKER
Inhalation Rate, (mg/cu m)	20
Exposure Time (hours/day)	80
Exposure Frequency (days/year)	250
Exposure Duration (years)	0.08
Body Weight (kilograms)	. 20
Averaging Time (years)	
Carcinogens	20
Noncarcinogens	0.08

R-8 DAILY INTAKE SOIL INHALATION FUTURE LAND USE SCENARIO - EXCAVATION WORKERS TABLE

Noncarcinogenic Effect Exposure Assessment Site 3, Former County Garage, Alpena CRTC, Alpena, MI

		Exposure	Inhalation	Exposure	Exposure			
Chemical	Concentration	Duration	Rate	Time	Frequency	Weight	Time	intake Rate
	(ma/cn m)		(cn m/hr)	(hours/day)	(days/yr)	(kg)	(days)	(mg/kg-day)
Benzo(a)nvrene	2.210E-06		20	80	250	70	29.2	3.460E-06
Dibenzofiran	1 721E-06		20	80	250	70	29.2	2.694E-06
Phenanthrene	5.588E-06	0.08	20	∞	250	20	29.2	8.748E-06

TABLE

R-9 DAILY INTAKE - ADULT SOIL INHALATION FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

Carcinogenic Effect Exposure Assessment

		Exposure	Inhalation	Exposure	Exposure			
Chemical	Concentration	Duration	Rate	Time	Frequency	Weight	Time	Intake Rate
	(ma/cn m)	(vears)	(cn m/hr)	(hours/day)	(days/yr)	(kg)	(days)	(mg/kg-day
Senzo(a)nvrene	2.210E-06	0.08	20	80	250	70	25550	3.954E-09
ishonandiran	1 7215-06	0.08	20	80	250	20	25550	3.079E-09
Phenanthrene	5.588E-06	0.08	20	60	250	70	25550	9.998E-09

TABLE R-10 BOIL INHALATION MODEL CALCULATIONS Site 3, Former County Garage, Alpena CRTC, Alpena, Mi

Construction work				
Dust Laading Factor (g/m²3) Conversion Factor	0.001	e ing		
Computations Computations W()M, 1994 W()M, 1994 C(all, mg/m*3		Banzold)pyana 0.200994 2.21E-06 1.33E-06	Dibencofumn 0.17206695 1.7206956-06 (1.0324017-06	Phenanthrene 0.55879078 5.5879078E-06 3.357448E-06

z	Alpena, MI
CALCULATIO	Alpena CRTC,
ATION MODE	ounty Garage,
R-11 SOIL INHALATION MODEL CALCULATION	Site 3, Former County Garage, Alpena CRTC, Alpena,
W.	•

		Febs 0.55879078 6695 0.55879078 6-06 2.23516379E-06
		Dbeazofuren 0.17206695 1.7706695E-06 6.692619E-07
	0.0	Benzo(a)pyrane 0.220994 2.2 IE:06 9.84E:07
	6,6m 6,6m	
age, Alpena CRTC, Alpena, MI	00,7	
Ske 3, Former County Garage, Alpana CRTC, Alpena, MI	Sonstruction traffic Dust Loading Factor (g/mr/3) Conversion Factor	Computations (U), mapkg (U), mapkg (clen), mapm 3

TABLE R-M SUBCHRONIC HAZARDOUS INDEX ESTIMATE - SOIL INCESTION FUTURE LAND USE SCENARIO - ESCAVATION WORKERS Howeverlogence Effects

NN Total 1c Pathway 5k Risk	, je
EXCAVATION Chemical- Specific Risk	3E-06
Madifying Factor	
OTO Source	HEAST 93 (1) HEAST 93 (1)
C.nhear Ethoct	() 194 NDGATA 194 0.3 P.14
Subchrowe RP (mg/kg-lay)	03 ND GATA 03
CD) Adjusted for Absorption	
Excansison Violen CDI (mylogodi)	1 (4E:06 8 13E:07 2 62E:06
Chemic, pt	Benzo(a)pyrene Dibenzofuran Phenanthrene

1) Subhronic RID for pyrene was used (HEAST 93)

TABLE R-16 CANCER ESTIMATE - SOIL INDESTION FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

Carcinogenic Effects

	CXCGAGIIGH						MOLLANACKS
	Worker	5					NO LONGOVO
							Chemica
	00	Adjusted for	N.	Weight of	Type of		Specif
mical	(mg/kg-day)	Absorphan	(mg/kg-dav)^11	Furdense	Cancar		
Benzo(a)pyrene	1 186E-09	ON	7.3	A)	Fore Stomach	HE ACT 03	0 30
Physhiran	9 286F-10	ON	EVIDENCE ON	919			0-36
		2	TO L'AIDCIACL	1974	Lung Inorax, Liver, Skin		0+30
กสกเทายาย	7 8886-08	OX	NO EVIDENCE	NA		HEAST 93) • 30
							0E+00

TABLE R-12 CANCER ESTIMATE - DERMAL CONTACT WITH SOILS FUTURE LAND USE SCENARIO - EXCAVATION WORKER

Excavelion Chemical-Specific Risk 2E-07 0E+00 0E+00 Source € € Type of Cancer ž ž Weight of Evidence N B2 NO EVIDENCE
No Evidence Adjusted for Absorption VES VES VES Cercinoganic Effects
Site 3, Former County Genege, Alpena CRTC, Alpena, Mil.
Eccardion
Viorine
Themical (mg/kg-dey)
Bancolumy (mg/kg-dey)
1395-09
13505-08 Chemical Benzo(a)pyrene Dibenzofuren Phenanthrene

Total Pathway Risk

(a) SF for berzo(a) pyrane used (RNS, 93).
- Adjusted from administered and absorbed dose by assuming an efficiency of 0,17 (ASTDR 1990 for berzop(a)pyrane) and 0.67 for Chrysene (ASTDR 1990)

TABLE R-13 SUBCHRONIC HAZARDOUS INDEX ESTIMATE - DERMAL CONTACT WITH SOILS FUTURE LAND USE SCENARIO - EXCAVATION WORKER

avetton forker CDI	CDI Subchronic Adjusied for RfD*	Critical	R.O.	Modifying	Chemical- Specific Risk	Total Pathway Risk
(mg/kg-day) erzo(e)pyane 4,6172-06 1,6172-06 1,181E-05 1,181E-05	Absorption (mg/kg-day) YES NO DATA YES NO DATA YES NO DATA	NA AN	(e) (e)		9E-05	

(a) RtD for benzo(a) pyrene used (HEAST, 93).

TABLE R-16 CANCER RISK ESTIMATE - SOIL INHALATION FUTURE LAND USE SCENARIO - EXCAVATION WORKER

Sife 3, Former County	Carcinogenic Effects Site 3, Former County Garage, Alpena CRTC, Alpena, MI						
						Excavetion	
	Excevation	CDI				Chemical-	Total
	iQ:	Adjusted for SF	Welght of	Type of	45	Space	Pathway
Chemical	(mg/kg-day)	Absorption (mg/kg-day)~1	Evidence	Cancer	Source	Risk	Risk
3enzo(a)pyrene	3.954E-09	NO 7.3	82	Respiratory Treci	IRIS 93	3E-08	
Olbenzofuran	3,079E-09	NO NO EVIDENCE	¥Z.	AZ.	A.V	0F+40	
henanthrene	9.998E-09	NO NO EVIDENCE	N.A.	N.	¥		
Total							3E.08

1) Oral slope factor for benzo(a)pyrene was used, IRIS.

TABLE R-17 SUBCHRONIC HAZARDOUS INDEX ESTIMATE - SOIL INHALATION FUTURE LAND USE SCENARIO - EXCAVATION WORKER

Noncardingenic Effects Site 3, Formsr County Garage, Alpens CRTC, Alpens, Mi

Excavation CD? Subchronic					
				Technology.	Total
CDI Adjusted for RtD	Critical	£	Modifying		Pathway
,	Effect	Source	Factor	35186	Risk
Benzo(a)pyrene 3.460E-06 0.3	NA AN	HEAST 93		15-05	
tbenzoNran 2.694E-06 ND	NA	HEAST 93	-		
NO 0.0057	Liver	CA EPA 92	-	2E-03	

Groundwater Solute Transport Model Data - Site 3

Theoretical Background

A two-dimensional Method of Characteristics (MOC) solute transport model (Konikow and Bredehoeft, 1989) was used for preliminary examination of contaminant migration within the shallow aquifer beneath the Alpena CRTC. The model is designed to calculate transient changes in solute concentrations within groundwater by simultaneously solving partial differential equations describing groundwater flow and transport and computes the change in a chemicals concentration over time. Changes in chemical concentrations over time are caused by the processes of convective transport, hydrodynamic dispersion, and mixing from fluid sources. This model couples the groundwater flow equation with solute transport equations.

The flow equation can be approximated by an implicit finite-difference equation. The model area is discretized into a rectangular grid with each square being a node. The finite difference equation is solved numerically for each node in the grid using an iterative alternating-direction implicit (ADI) procedure.

After the hydraulic head distribution is calculated, the velocity of groundwater flow can be computed at each node. The expression for average velocity of groundwater can be derived from Darcy's law. The groundwater velocity at each node is calculated utilizing an explicit finite-difference approximation of Darcy's law. The computer program uses an alternating-direction implicit procedure to solve a finite-difference approximation to the groundwater flow equation, and it uses the method of characteristics (MOC) to solve the solute transport equation. MOC uses a particle tracking procedure to represent convective transport and a two-step, explicit procedure to solve a finite-difference equation that describes the effects of hydrodynamic dispersion, fluid sources and sinks, and divergence of velocity.

A number of assumptions are inherent in the solute transport model:

- Darcy's law is valid and hydraulic head gradients are the only significant driving mechanism for fluid flow.
- 2. The porosity and hydraulic conductivity of the aquifer are constant with time, and porosity is uniform in space.
- 3. Gradients of fluid density, viscosity, and temperature do not affect the velocity distribution.
- 4. No chemical reactions occur that affect the concentration of the solute, the fluid properties, or the aquifer properties.
- 5. Ionic and molecular diffusion are negligible contributors to the total dispersive flux.

- 6. Vertical variations in head and concentrations are negligible.
- 7. The aquifer is homogeneous and isotropic with respect to the coefficients of longitudinal and transverse dispersivity.

Transport Model Input

A model grid of 32 columns by 19 rows with a 250 foot lateral spacing was used. Specified head cells were used at nodes corresponding to the South Branch of the Thunder Bay River, at nodes along the eastern boundary of the model grid area, and also at the sinkhole in the northeastern portion of the model. Groundwater elevations measured during September, 1993 were used as initial input into the transport model. Hydraulic conductivity values were calculated from slug tests performed at Alpena CRTC (Engineering Science, 1989; Earth Technology, 1994). Values of hydraulic conductivity range from 12 feet/day at Site 4 to 278 feet/day at Site 3.

Aquifer thickness values were obtained from drilling records of monitoring wells and soil borings obtained from the SI and RI field activities. Values listed are from logs in which the thickness of the shallow aquifer was clearly discernible, and ranged from 20 feet at Site 5 to 65 feet at Site 8. Transmissivity values were calculated by multiplying the calculated hydraulic conductivity values by the aquifer thickness. Transmissivity ranges from 420 ft²/day at TF4-MW3 to 15,290 ft²/day at CG3-MW5.

Monitoring of the discharge of springs into the sinkhole was performed during the SI (Engineering Science, 1990) and an estimate of approximately 18,000 gallons of water per day discharging into the sinkhole was calculated. In order to obtain a numerical estimate of discharge into the sinkhole for the model, MODFLOW (McDonald and Harbaugh, 1988), a 3- dimensional finite-difference groundwater flow model was used. MODFLOW was used because of its ability to simulate the effect of head-dependent groundwater flow into a groundwater sink (i.e. the sinkhole). This package was not available in MOC. The same model parameters and boundary conditions were used within MODFLOW as in MOC. Based upon hydraulic head data collected in September 1993, discharge from the shallow aquifer into the sinkhole is approximately 30,000 gallons per day.

The dispersivity of an aquifer in two dimensions is described by the longitudinal dispersion, the transverse dispersion and the ratio of the two (Fetter, 1993). As a contaminant plume moves further from its initial location within the aquifer by advection with the groundwater flow, the plume spreads. The spreading in the direction of groundwater flow is the longitudinal dispersion, the spreading in the direction perpendicular to the groundwater flow is known as the transverse dispersion (Fetter, 1993). The values of the dispersion coefficients are typically derived via bench scale tests, aquifer tests, or calibration of contaminant transport models. Since no data presently exists describing dispersivity within the shallow aquifer beneath the Alpena CRTC and insufficient data exists to allow for derivation of dispersivity via model calibration, moderate values of 100 feet for longitudinal dispersivity and 30 feet for transverse dispersivity were chosen (Gillham and

Cherry, 1982). A more complete description of the model is given in the report, Preliminary Groundwater Modeling Effort, Earth Technology, August 1993.

Model Calibration:

The groundwater flow model was calibrated with respect to the September 1993 groundwater elevation measurements. Calibration of the groundwater flow model was accomplished by defining a set of parameters, boundary conditions, and stresses that produce simulated heads and fluxes that match field-measured values within a preestablished range of error (Anderson and Woessner, 1992). In order to match field measured values for hydraulic head as determined during September 1993, a few modifications were made to the preexisting groundwater flow model. These changes included updating the initial head array, modeling the sinkhole as a constant head cell to account for the large gradient changes in the vicinity of the sinkhole and including recharge to the model at a rate of 9 inches per year over the whole model area. By adjusting these parameters, an acceptable level of calibration was achieved. An acceptable level of calibration was defined as a root mean squared error (RMS) of less than 2 feet. The RMS, or the standard deviation is the average squared difference in measured and simulated heads and is given by the equation:

RMS=
$$[1/n\sum_{i=1}^{n} (h_m - h_s)_{i}^{2}]^{0.5}$$

n = number of wells
 h_m = measured head
 h_• = model simulated head

Certain portions of the model may have values above the goal of 2 feet while others fall much below this value. The RMS represents the average error present in the model. The following provides a summary of the final calibrated heads for the flow model.

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
MP2MW1	10,25	679.69	676.68	3.01
MP2MW3	10,22	675.51	675.46	0.05
MP2MW4 5*	11,23	675.34	675.70	-0.36
MP2MW6	11,20	674.86	674.52	0.34
CG3MW1	6,24	677.38	676.69	0.69
CG3MW2	7,22	676.29	675.78	0.51

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
сдзмwз	9,23	676.50	675.98	0.52
CG3MW4_5*	8,23	676.41	676.08	0.33
CG3MW7	8,20	675.64	674.80	0.84
TF4MW1	7,9	667.23	668.83	-1.60
TF4MW2	8,10	659.61	664.22	-4.61
TF4MW3_4*	9,10	658.21	660.06	-1.85
SF5MW1	12,6	674.15	671.34	2.81
SF5MW2	14,5	675.32	672.67	2.65
SF5MW3_4*	13,6	676.46	671.64	4.82
SF5MW6	13,5	674.26	672.40	1.86
LF6MW1	14,9	672.1	670.40	1.70
LF6MW2	14,8	672.68	670.72	1.96
LF6MW3	14,10	671.93	670.21	1.72
LF6MW4	16,7	672.75	671.91	0.84
LF6MW5	15,7	673.07	671.56	1.51
LF6MW6	13,10	671.17	669.67	1.50
LF6MW8	15,9	673.12	670.78	2.34
HN8MW1	5,22	676.96	675.93	1.03
HN8MW2	6,19	675.31	674.50	0.81
HN8MW3_4*	7,21	676.01	675.35	0.66
RT9MW1	6,16	673.06	672.78	0.28
RT9MW2	7,14	668.21	670.81	-2.60
RT9MW3	9,15	670.72	671.26	-0.54
RT9MW4_5*	8,14	667.47	670.32	-2.85
RT9MW6	8,16 -	670.58	672.33	-1.75
S1MW2	13,26	677.39	676.63	0.76

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
S1MW3	13,27	677.15	676.98	0.17
S1MW11	15,24	675.72	675.67	0.05
S1MW12	16,25	674.55	675.94	-1.39
S1MW13	14,24	675.21	675.76	-0.55
S1MW14	14,25	673.92	676.14	-2.22
MP2MW2	12,24	675.57	675.96	-0.39

^{*} Indicates that more than one well is present in each node and an average value for hydraulic head was used.

Sum of Squared Residuals = 128.78/38 = 3.3891 Root Mean Squared Error = 1.84

It should also be noted that the model was calibrated with respect to the September 1993 water level data and should only be considered calibrated with respect to this data. More information on the water level fluctuation through time would be needed to perform a transient calibration. The model was not calibrated with respect to concentration data, but only with respect to hydraulic head.

Model Assumptions and Limitations

- * The model domain consisted only of the shallow unconfined aquifer (i.e. one layer).
- * The initial head data input to the transport model are results of measurements taken in September 1993.
- * Initial concentrations of compounds are results of the Round IV sampling event which was conducted from July to September 1993.
- * Hydraulic conductivity values are the result of slug tests performed in November, 1987 and September 1993.
- * The model was calibrated with respect to hydraulic head using September 1993 water level data and should only be considered calibrated with respect to September 1993 water level data.
- * The flow model was assumed to be at steady-state with respect to hydraulic head.

Site 3

No organic compounds or inorganics exceeding the Act 307 Type A or B cleanup criteria were present in the shallow aquifer at this site.

Appendix S: Site 4 Risk Assessment

Table S-1A

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Groundwater - Site 4

MIANG, Alpena CRTC, Alpena, MI

RESULT	3.2000
ANALYTE	bis(2-Ethylhexyl)phthalate
MATRIX	GROUNDWATER
SAMPLEID	PC-TF4-MW1-GW4
LOCATOR	MW1
SITE	PC-TF4

Table S-2A

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Sediment - Site 4

MIANG, Alpena CRTC, Alpena, MI

SITE	LOCATOR	SAMPLE ID	MATRIX	ANALYTE	SAMPLE DEPTH RANGE	I	RESULT
PC-TF4	SD001	PC-TF4-SD001	SEDIMENT	4-Methylphenol	0.0000	0.0000	365.0000
PC-TF4	SD001	PC-TF4-SD001	SEDIMENT	Selenium	00000	0.0000	1.1000
PC-TF4	SD001A	PC-TF4-SD001A	SEDIMENT	Methylene chloride	0.0000	0.0000	4.2000
PC-TF4	SD001A	PC-TF4-SD001A	SEDIMENT	Selenium	00000	0.000	0.2150
PC-TF4	SD001A	PC-TF4-SD001A	SEDIMENT	4-Methylphenol	0.0000	0.0000	235.0000
PC-TF4	SD002B	PC-TF4-SD002B	SEDIMENT	Selenium	0.0000	0.0000	0.2150
PC-TF4	SD002B	PC-TF4-SD002B	SEDIMENT	Methylene chloride	00000	0.000	5.6000
PC-TF4	SD002B	PC-TF4-SD002B	SEDIMENT	4-Methylphenol	0.0000	0.0000	235.0000
PC-TF4	SD003	PC-TF4-SD003	SEDIMENT	4-Methylphenol	0.0000	0.000	220.0000
PC-TF4	SD003	PC-TF4-SD003	SEDIMENT	Selenium	0.0000	0.0000	0.4200
PC-TF4	SDOGS	PC-TF4-SD003	SEDIMENT	Methylene chloride	0.0000	0.0000	12.0000
PC-TF4	SD004A	PC-TF4-SD004A	SEDIMENT	Methylene chloride	0.0000	0.000	4.9000
PC-TF4	SD004A	PC-TF4-SD004A	SEDIMENT	4-Methylphenol	0.0000	0.0000	215.0000
PC-TF4	SD004A	PC-TF4-SD004A	SEDIMENT	Selenium	0.0000	0.0000	0.1950
PC-TF4	SD004B	PC-TF4-SD004B	SEDIMENT	Methylene chloride	0.0000	0.0000	2.8000
PC-TF4	SD004B	PC-TF4-SD004B	SEDIMENT	Selenium	0.0000	0.0000	0.2000
PC-TF4	SD004B	PC-TF4-SD004B	SEDIMENT	4-Methylphenol	0.000	00000	217.0000
PC-TF4	SD005A	PC-TF4-SD005A	SEDIMENT	4-Methylphenol	0.000	0.0000	315,0000
PC-TF4	SD005A	PC-TF4-SD005A	SEDIMENT	Selenium	0.0000	0.0000	0.7200
PC-TF4	SD005B	PC-TF4-SD005B	SEDIMENT	4-Methylphenol	0.0000	0.0000	215,0000
PC-TF4	SD005B	PC-TF4-SD005B	SEDIMENT	Selenium	0.000	0.0000	0.2000
PC-TF4	SD005B	PC-TF4-SD005B	SEDIMENT	Methylene chloride	0.000	0.0000	16.0000
PC-TF4	SD006A	PC-TF4-SD006A	SEDIMENT	Selenium	0.000	0.0000	0.2000
PC-TF4	SD006A	PC-TF4-SD006A	SEDIMENT	4-Methylphenof	0.000	0.0000	215.0000
PC-TF4	SD006A	PC-TF4-SD006A	SEDIMENT:	Methylene chloride	0.000	0.0000	2:9000
PC-TF4	SD006B	PC-TF4-SD006B	SEDIMENT	Selenium	0.0000	0.0000	0.2200
PC-TF4	SD006B	PC-TF4-SD006B	SEDIMENT	4-Methylphenol	0.0000	0.0000	144.0000
PC-TF4	SD009A	PC-TF4-SD009A	SEDIMENT	Methylene chloride	0.000	0.0000	1.9000
PC-TF4	SD009A	PC-TF4-SD009A	SEDIMENT	4-Methylphenol	0.0000	0.000	170.0000
PC-TF4	SD009A	PC-TF4-SD009A	SEDIMENT	Selenium	0.000	0.0000	0.1550
PC-TF4	SD010A	PC-TF4-SD010A	SEDIMENT	4-Methylphenol	0.000	0.0000	250.0000
PC-TF4	SD010A	PC-TF4-SD010A	SEDIMENT	Selenium	0.000	0.0000	0.2300
PC-TF4	SD010A	PC-TF4-SD010A	SEDIMENT	Methylene chloride	0.0000	0.0000	0.7500

Table S-3A
Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Surface Water - Site 4
MIANG, Alpena CRTC, Alpena, MI

ш	LOCATOR	SAMPLEID	MATRIX	ANALYTE	RESULT
1100	CIAIORE	DC_TEA_C\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	SURFACE WATER	Selenium, Dissolved	3.5000
アン・174	2000			postocoio minimoleo	1 5000
DC-TF4	SW007	PC-TF4-SW007	SURFACE WALER	Selement, Dissolved	2000
1 H C C	8/0/0/8	PC-TEA-SW/008	SURFACE WATER	Selenium, Dissolved	1.5000
4L-0L	2000			Trichlorothylono	1 2000
PC-TF4	SW006	PC-TF4-SW006	SURFACE WATER	I I I CI II OLOGINI À I CI II C	2007:1
DC 754	2/0/007	PC-TF4-SW007	SURFACE WATER	Trichloroethylene	0.1500
1 - 1	0000	00 TEA C/A/008	SUBEACE WATER	Trichloroethylene	0.0950

TABLE S-1 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH SEDIMENTS SIDE 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

			ľ
PARAMETER	ADULT	CHILD	
Skin Surface Area Available for Contact (cm ² 2/day)	3120	1490	
Soil to Skin Adherence Factor (mg/cm ² 2)	2.77	77.6	
Absorption Factor, Unitless			
Metals	0.01	0.01	
Organics	0.25	0.25	
Exposure Factor (days/year)	48	4	
Exposure Duration (year)	25	15	
Body Weight (kilograms)	. 02	27	
Conversion Factor	15-06	15-06	
Averaging Time, years		!	
Carcinogens	70	70	
Noncarcinogens	25	5 4	

SITE4.WB1/940127

TABLE S-2 DAILY INTAKE - ADULT DERMAL CONTACT WITH SEDIMENTS FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 4 Third Fire Training Area, Alpena CRTC, Alpena, Mi

	- de la companya de l	Conversion		Soil to	Absorption		Exposure	Body	Average	Absorbed
		Factor	Skin Surface	Skin Adherence	Factor	Frequency	Duration	Weight	Time	Dose
Chemical	Collection and	(ka/ma)		(ma/cm ²)	(unitless)		(years)	(kg)	(days)	(mg/kg-day)
	(By/Bur)	1 005 06	1	277	0.01	1	25	20	9125	7.915E-08
Selenium	4.8/3E-01	00-100.		1	200		, K	20	9125	3.573E-08
Methylene chloride	8.802E-03	1.00E-06		11.7	0.43	9 5	3 2	2 6	0426	4 OROE OR
4-Methylphenol	2.634E-01	1.00E-06		2.11	0.25	48	c	0	C716	3000

TABLE S-3 DAILY INTAKE - CHILD DERMAL CONTACT WITH SEDIMENTS FUTURE LAND USE SCENARIO Noncarcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

Absorbed Dose (mg/kg-day) 9.800E-08 4.424E-08 1.324E-08 Average | Time | (days) | 5475 | 5475 | Body Weight (kg) 27 27 27 Exposure
Duration
(years)
15
15 Exposure Frequency (days/year) 48 48 Absorption Factor (unifless) 0.01 0.25 Soil to Skin Adherence (mg/cm^2) 2.77 2.77 2.77 Avaitable Skin Surface (cm^2/day) 1490 1490 1490 Conversion Factor (kg/mg) 1.00E-06 1.00E-06 Chemical Concentration (mg/kg) 4.875E-01 8.802E-03 Selenium Methylene chloride 4-Methylphenol Chemical

S-4 DAILY INTAKE - ADULT DERMAL CONTACT WITH SEDIMENTS FUTURE LAND USE SCENARIO TABLE

Carchogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

	Soil to	Absorption	Exposure	Exposure	Body	Average	Absorbed
	Skin Adherence	Factor	Frequency	Duration	Weight	Time	Dose
	(mg/cm ²)	(unifiess)	(days/year)	(years)	(kg)	(days)	(mg/kg-day)
	2.77	0.01	48	25	70	25550	2.827E-08
	2.77	0.25	48	25	70	25550	1.276E-08
	2.77	0.25	48	25	70	25550	3.818E-07
1.0E-06 3120 1.0E-06 3120 1.0E-06 3120	2.77 77.2 77.2	7.7.	77 0.01 77 0.25 77 0.25	0.01 0.25 0.25	0.01 48 0.25 48 0.25 48	0.01 48 25 0.25 48 25 0.25 48 25	0.01 48 25 0.25 48 25 0.25 48 25

TABLE S-6 DAILY INTAKE - CHILD DERMAL CONTACT WITH SEDIMENTS FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

Chemical	Chemical Concentration (mg/kg)	Conversion Factor (kg/mg)	•,	Soil to Skin Adherence (mg/cm²2)	Absorption Factor (unitiess)	Exposure Frequency (days/year)	Exposure Duration (years)	Body Weight (kg)	Average Time (days)	Absorbed Dose (mg/kg-dav)
Sefenium	4.875E-01	1.0E-06	1490	77.2	0.01		15	72	25550	2.100E-08
Metrytens chloride	8.802E-03	1.0E-06	1490	77.2	0.25		15	72	25550	9.479E-09
4-Metrytphenol	2.634E-01	1.0E-06	1490	77.2	0.25		51	72	25550	2.836E-07

SITE4.WB1/ 940127

TABLE S-6 EXPOSURE ASSESSMENT PARAMETERS - SEDIMENT INGESTION Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

PARAMETER	CHILD	ADULT
	;	9
Ingestion Rate (mg/day)	200	001
Fraction Ingested from	•	•
Contaminated Sources (unitless)		- ;
Exposure Frequency (days/year)	400	894
Company Design (seems)	9	52
Exposure Cultural (years)	15	02
Body Weight (Kilograms)	20 11	15.06
Conversion Factor	97-11	3
Averaging Time	i	ç
Carcinogens	0/	2 6
Noncarcinodens	မွ	52

TABLE S-7 DAILY INTAKE - ADULT SEDIMENT INGESTION FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Apena CRTC, Alpena, MI

į	Chemical	Conversion		Fraction	Exposure	Exposure	Body	Average	
Chemical	Concentration	Rate	Ingestion Rate	Ingested	Frequency	Duration	Weight	TIMe	intake Rate
	(mg/kg)		(mg/day)	(nuitess)	(days/year)	(years)	(kg)	(davs)	(ma/ka-dav)
Selenium	4.875E-01	1E-06	100	-	48	25	70	9125	9 158F-08
Methylene chloride	8.802E-03	1E-06	100	-	48	25	70	9125	1,654E-09
4-Methylphenol	2.634E-01	1E-06	100	-	48	25	70	9125	4.948E-08
4-Methylphenol	2.634E-01	1E-06	100	-	48	25		70	70 9125

TABLE S-8 DAILY INTAKE CHILD SEDIMENT INGESTION FUTURE LAND USE SCENARIO Noncarcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

Chemical	Chemical Concentration (mg/kg)	Conversion Rate Inges	ngestion Rate (mg/day)	Fraction Ingested (unitless)	Exposure Frequency (days/year)	Exposure Duration (vears)	Body Weight (kg)	Average Time (davs)	Intake Rate
Selenium Methylehe chloride 4-Methylphenol	4.875E-01 8.802E-03 2.634E-01	1E-06 1E-06 1E-06	200 200 200		48 48 48 88 48	999	15 15 15	2190 2190 2190	8.548E-07 1.543E-08 4.618E-07

TABLE S-9 DAILY INTAKE - ADULT SEDIMENT INGESTION FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 4. Third Fire Training Area, Alpena CRTC, Alpena, MI.

	Average Intake Rate Time (mg/kg-day)	5550 5.27 IE-20 5550 5.96E-10 5550 1.767E-08
	Body Ave Weight (kg) (
	Exposure Duration (years)	25 25 25
	Exposure Frequency (days/year)	48
	Fraction Ingested (unitless)	
	Ingestion Rate (mg/day)	100 100 100
	Conversion Rate	1E-06 1E-06 1E-06
Site 4, Inite Fire training Aga, Apena Carc, Apena, init	Chemical Concentration (marker)	4.875E-01 8.802E-03 2.634E-01
Site 4, in	Chemical	Selenium Methylene chloride 4-Methylphenol

TABLE S-10 DAILY INTAKE - CHILD SEDIMENT INGESTION FUTURE LAND USE SCENARIO Carcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Apena, MI

Exposure Exposure Body Average Intake Rate Frequency Duration Weight Time Intake Rate (days/year) (years) (kg) (days)	48 6 15 25550 7.3Z/E-09 48 6 15 25550 1.3Z3E-09 48 6 15 25550 3.958E-08
Fraction Ingested (unitless)	
Conversion Rate Ingestion Rate (mg/day)	1E-06 200 1E-06 200 1E-06 200
Chemical Concentration (market)	4.1976E-01 8.802E-03 2.634E-01
Chemical	Selenium Metryfene chloride 4-Metryfphenol

TABLE S-11 EXPOSURE ASSESSMENT PARAMETERS - FISH INGESTION Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	CHILD	
Fraction of Fish Ingested, unitless	0.5	0.5	
Ingestion rate kg/day	0.054	0.043	
Exposure Frequency days/yr	26	26	
Exposure Duration (years)	25	15	
Body Weight, Kg	70	27	
Averaging Time			
Carcinogens	70	70	
Noncarcinogens	25	15	

SITÉ4.WB1/940127

TABLE S-12 DAILY INTAKE - ADULT FISH INGESTION FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

Chemical	Chemical * Concentration	Ingestion Rate	Exposure Frequency (davs/vear)	Fraction Ingested (unitless)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Intake Rate (mg/Kg-day)
Trichloroethylene Selenium, dissolved	(mg/kg) 4.680E-02 3.500E-03	0.054	26	0.5	25 25	07 07	9125 9125	1.286E-06 9.616E-08
Carbon Tetrachloride Tetrachloroethylene Arsanic Benzene Styrane 1,2 Dichlorethane 2 Methylnapthalene Lead	1.377E-03 1.624E-03 2.000E-06 3.722E-02 1.000E-03 6.300E-03 5.100E-03 4.000E-04	0.054 0.054 0.054 0.054 0.054 0.054 0.054	26 26 26 26 26 26 26 26 26 26	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	25 25 25 25 25 25 25 25 25 25 25 25 25 2	70 70 70 70 70 70 70 70 70	9125 9125 9125 9125 9125 9125	3.783E-08 4.462E-08 5.495E-11 1.023E-06 2.7495E-10 1.731E-07 1.099E-08

^{*} Adjusted from surface water to fish concentrations by use of bioconcentration factors, Cr=20, Cu=50.

S-13 DAILY INTAKE - CHILD FISH INGESTION FUTURE LAND USE SCENARIO TABLE

Noncarcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

Chemical	Chemical * Concentration	Ingestion Rate (kg/day)	Exposure Frequency (davs/vear)	Fraction Ingested (unitless)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Rate (mg/Kg-day)
Trichloroethylene Selenium, dissolved	4.680E-02 3.500E-03	0.043	26 26	0.5	15 15	27 27	5475 5475	2.655E-06 1.985E-07
Carbon Tetrachloride Tetrachloroethylene Arsenic Benzene Styrene 1, 2 Dichlorethane 1, 4 Dichlorobenzene 2 Methylnapthalene Lead	1.377E-03 1.624E-03 2.000E-06 3.722E-02 1.000E-03 2.000E-05 6.300E-03 5.100E-03 4.000E-04	0.043 0.043 0.043 0.043 0.043 0.043 0.043	26 26 26 26 26 26 26 26 26	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	27 27 27 27 27 27 27	5475 5475 5475 5475 5475 5475 5475 5475	7.811E-08 9.212E-08 1.134E-10 2.111E-05 5.672E-09 3.574E-07 2.893E-07 2.269E-08

^{*} Adjusted from surface water to fish concentrations by use of bioconcentration factors, Cr=20, Cu=50.

TABLE S-14 DAILY INTAKE - ADULT FISH INGESTION FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

	Chemical	Ingestion	Exposure	Fraction	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Ingested	Duration	Weight	Time	Rate
	(mg/kg)	(kg/day)	(days/year)	(unitless)	(years)	(kg)	(days)	(ma/Ka-dav)
Trichloroethylene	4.680E-02	0.054	26	0.5	25	70	25550	4.592E-07
Selenium, dissolved	3.500E-03	0.054	26	0.5	25	70	25550	3.434E-08
Carbon Tetrachloride	1.377E-03	0.054	26	0,5	25	20	25550	1.351E-08
Tetrachloroethylene	1.624E-03	0.054	26	0.5	25	20	25550	1.594E-08
Arsenic	2.000E-06	0.054	26	0.5	25	70	25550	1.963E-11
Benzene	3.722E-02	0.054	26	0.5	25	70	25550	3.653E-07
Styrene	1.000E-03	0.054	26	0.5	25	70	25550	9.813E-09
1,2 Dichlorethane	2.000E-05	0.054	26	0.5	25	20	25550	1.963E-10
1,4 Dichlorobenzene	6.300E-03	0.054	26	0.5	25	20	25550	6.182E-08
2 Methylnapthalene	5.100E-03	0.054	26	0.5	25	70	25550	5.004E-08
Lead	4.000E-04	0.054	26	0.5	25	20	25550	3.925E-09

TABLE S-15 DAILY INTAKE - CHILD FISH INGESTION FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment
Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

	Chemical	Ingestion	Exposure	Fraction	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Ingested	Duration	Weight	Time	Rate
	(mg/kg)	(kg/day)	(days/year)	(unitless)	(years)	(kg)	(days)	(mg/Kg-dav)
Trichloroethylene	4.680E-02	0.043	26	0.5	15	27	25550	5.688E-07
Selenium, dissolved	3.500E-03	0.043	26	0.5	15	27	25550	4.254E-08
Carbon Letrachloride	1.377E-03	0.043	56	0.5	15	27	25550	1.674E-08
Tetrachloroethylene	1.624E-03	0.043	56	0.5	15	27	25550	1.974E-08
Arsenic	2.000E-06	0.043	56	0.5	15	27	25550	2.431E-11
Benzene	3.722E-02	0.043	56	0.5	15	27	25550	4.525E-07
Styrene	1.000E-03	0.043	26	0.5	15	27	25550	1.215E-08
1,2 Dichlorethane	2.000E-05	0.043	26	0.5	15	27	25550	2.431E-10
1,4 Dichlorobenzene	6.300E-03	0.043	26	0.5	15	27	25550	7.658E-08
2 Methyinapthalene	5.100E-03	0.043	26	0.5	15	27	25550	6.199E-08
Lead	4.000E-04	0.043	26	0.5	15	27	25550	4.862E-09

TABLE S-16 EXPOSURE ASSESSMENT PARAMETERS - INGESTION OF SURFACE WATER Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

	ADULT	CHILD
PARAMETER		
	26	2.6
Exposure Time (hrs/day)	. K	50
Surface Water Contact Rate (ml/hr)	48	48
Exposure Frequency (days/year)	5 55	15
Exposure Duration (years)	02	27
Body Weight, Kg	!	
Averaging Time	70	20
Carcinogens	25	15
Noncarcinogens	1	

TABLE S-17 DAILY INTAKE - ADULT SURFACE WATER INGESTION FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

	Chemical	Contact	Exposure	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(mg/kg)	(Uhr)	(days/year)	(hrs/day)	(vears)	(ka)	(davs)	(ma/Ka-dav)
Frichloroethylene	4.816E-04	0.050	48	2.6	25	70	9125	1.176E-07
Selenium, dissolved	2.100E-03	0.050	48	2.6	25	70	9125	5.129E-07
Carbon Tetrachloride	8.100E-05	0.050	48	2.6	25	20	9125	1.978E-08
Tetrachloroethylene	2.900E-05	0.050	48	2.6	25	20	9125	7.083E-09
Arsenic	2.000E-06	0.050	48	2.6	22	70	9125	4.885E-10
Benzene	1.551E-03	0.050	48	2.6	22	20	9125	3.788E-07
Styrene	1.000E-05	0.050	48	2.6	25	. 02	9125	2.442E-09
1,2 Dichlorethane	1.000E-05	0.050	48	2.6	22	70	9125	2.442E-09
1,4 Dichlorobenzene	1.050E-04	0.050	48	2.6	25	20	9125	2.564E-08
2 Methylnapthalene	1.000E-05	0.050	48	2.6	52	70	9125	2.442E-09
Lead	4.000E-06	0.050	48	2.6	22	20	9125	9.769E-10

TABLE S-18 DAILY INTAKE - CHILD SURFACE WATER INGESTION FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

	Chemical	Contact	Exposure	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(mg/kg)	(L/hr)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(mg/Kg-day)
l richloroethylene	4.816E-04	0.050	48	2.6	15	27	5475	3.049E-07
Selenium, dissolved	2.100E-03	0.050	48	2.6	15	27	5475	1.330E-06
Carbon Tetrachloride	8.100E-05	0.050	48	2.6	5	77	5475	5 129E-08
Tetrachloroethylene	2.900E-05	0.050	48	2.6	15	27	5475	1.836F-08
Arsenic	2.000E-06	0.050	48	2.6	15	27	5475	1.266E-09
Benzene	1.551E-03	0.050	48	2.6	15	27	5475	9.821E-07
Styrene	1.000E-05	0.050	48	2.6	15	27	5475	6.332E-09
1,2 Dichlorethane	1.000E-05	0.050	48	2.6	15	27	5475	6.332E-09
1,4 Dichlorobenzene	1.050E-04	0.050	48	2.6	15	27	5475	6.648E-08
2 Methylnapthalene	1.000E-05	0.050	48	2.6	15	27	5475	6.332E-09
Lead	4.000E-06	0.050	48	2.6	15	27	5475	2.533E-09

S-19 DAILY INTAKE - ADULT SURFACE WATER INGESTION FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

	Chemical	Contact	Exposure	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	e :	
	(ma/ka)	(Lhr)	(days/year)	(hrs/day)	(years)	(kg)	(days)	Ε
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A 816E-04	0.050	48	2.6	25	70	25550	7
Frichloroethylene	2 100E-03	0.050	48	2.6	25	20	25550	1.832E-07
Selenium, dissolved	20 100 17							
	9 1005	0.050	48	2.6	25	20	25550	7.065E-09
Carbon Tetrachloride	8.100E-03	0000	9 8	26	25	70	25550	2.529E-09
Tetrachloroethylene	Z.900E-U5	0.000	? :	o e	0 1	1	02220	1 7AAE 11
	2 000F-06	0.050	48	2.6	52	2	00007	1.446.
Arsenic	4 554E-03	0.050	48	2.6	52	20	25550	1.353E-0;
Benzene	1,000	0.000	48	26	25	20	25550	8.722E-1(
Styrene	1.000E-03	0.000	2 5	ic	3, 5,	202	25550	8 722E-10
1 2 Dichlorethane	1,000E-05	nenin	04	6.2	63	2	1	
ייי סופונים מונים	1 050E-04	0.050	48	2.6	52	2	25550	9.159E-0.
1,4 Dichioropenzene	1 0005	0.050	48	9 0	52	02	25550	8.722E-1(
12 Methylnapthalene	CO-3000.1	0000		i -	1 1	1	CHURC	2 400E 4
Lead	4.000E-06	0.050	48	2.6	52	2	00007	3.403E-1

S-20 DAILY INTAKE - CHILD SURFACE WATER INGESTION FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

Chemical	Chemical Concentration	Contact Rate (L/hr)	Exposure Frequency (davs/vear)	Exposure Time (hrs/day)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Intake Rate (mg/Kg-day)
Trichloroethylene Selenium, dissolved	1.200E-03 3.500E-03	0.050	48	2.6	15 15	27	25550 25550	1.628E-07 4.749E-07
Carbon Tetrachloride Tetrachloroethylene Arsenic Benzene Styrene 1,2 Dichlorethane 2 Methylnapthalene Lead	8.100E-05 2.900E-05 2.000E-06 1.551E-03 1.000E-05 1.050E-04 1.000E-05 4.000E-06	0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050 0.050	4 4 4 4 4 4 4 4 4 4 4 8 8 8 8 8 8 8 8 8	2 2 2 2 2 2 3 6 6 6 6 6 6 6 6 6 6 6 6 6	<u> </u>	27 27 27 27 27 27 27	25550 25550 25550 25550 25550 25550 25550 25550 25550	1.099E-08 3.935E-09 2.714E-10 2.104E-07 1.357E-09 1.357E-09 1.357E-09 5.427E-10

TABLE S-21 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH THUNDERBAY RIVER SURFACE WATER Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	CHILD
Skin Surface Area Available for Contact (sq cm)	19400	13300
Exposure Time (hrs/day)	2.6	2.6
Dermal Permeability Constant	0.00084	0.00084
Exposure Frequency (days/year)	48	48
Exposure Duration (years)	25	15
Body Weight, Kg	70	27
Averaging Time		
Carcinogens	70	70
Noncarcinogens	25	15
Conversion Factor	0.001	

S-22 DAILY INTAKE - ADULT SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Noncardinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

		Chemical	Dermal	Skin	Exposure	Exposure	Exposure	Meight	Avelaging	Conversion	Rate
Chemical		Concentration	Permeability	Surface Area	requency (days/year)	(hrs/dav)	(vears)	(kg)	(days)	(I/cn cm)	(mg/Kg-day
		(mgn)	THE STATE OF THE S	40400	AB AB	26	25	70	9125	0.001	2.274E-05
Trichloroethylene Selenium, dissolved	(c) (g)	1,200E-03 3,500E-03	0.001	19400	48	2.6	25	20	9125	0.001	3.317E-07
	:	1	000	10400	87	26	25	70	9125	0.001	1.689E-07
Carbon Tetrachloride	<u>(a)</u>	8.100E-05	0.022	10400	48	2.50	25	202	9125	0.001	1.099E-06
Tetrachloroethylene	(a)	2.900E-05	4.0	10400	2 4	9 6	25	70	9125	0.001	1.895E-10
Arsenic	(O)	2.000E-06	0.001	10400	2 00	9 6	25	20	9125	0.001	1.470E-0
Benzene	(a)	1.551E-03	0.1	19400	0 0	0 40	3, 2,	102	9125	0.001	7.960E-1(
Styrene		1,000E-05	0.00084	19400	5 4		2 4	202	9125	0.001	5.022E-00
1,2 Dichlorethane	Q Q	1.000E-05	0.0053	19400	0	0.70	5 K	2.5	9125	0 001	6.169E-0
1,4 Dichlorobenzene	(Q)	1.050E-04	0.062	19400	84 6	0.7	27.	2.2	9125	0 001	9.476E-11
2 Methylnanthalene	(0)	1.000E-05	0.001	19400	48	0.7	07	- 1	0400	2000	4 546E 42
l ead	(a)	4.000E-06	4E-06	19400	48	2.6	25	R	6716	0.00	

(a) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992a).
 (b) Predicted PC (Table 5-7 of U.S. EPA, 1992a).
 (c) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).

S-23 DAILY INTAKE - CHILD SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Noncarcinogenic Effect Exposure Assessment Site 4. Third Fire Training Area, Alpena CRTC, Alpena, MI

Chemical		Chemical Concentration	Dermal Permeability	Skin Surface Area	Exposure Frequency (days/year)	Exposure Time (hrs/dav)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Factor (I/cu cm)	Rate (mg/Kg-day)
Trichloroethylene Selenium, dissolved	(a) (b)	(mg/) 1.200E-03 3.500E-03	0.001	13300	48	2.6	15 15	27 27	5475 5475	0.001	4.042E-05 5.895E-07
Carbon Tetrachloride Tetrachloroethylene Arsenic Benzene Slyrene 1, 2 Dichlorobenzene 1, 4 Dichlorobenzene C Methylnapthalene Lead	(a) (a) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c	8.100E-05 2.900E-05 2.000E-06 1.551E-03 1.000E-05 1.000E-05 1.000E-05 4.000E-06	0.022 0.4 0.001 0.00084 0.0053 0.062 0.062 0.062	13300 13300 13300 13300 13300 13300 13300	4 4 4 4 8 8 8 8 4 4 4 8 8 8 8 8 8 8 8 8	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	27 27 27 27 27 27 27 27 27 27 27 27 27 2	5475 5475 5475 5475 5475 5475 5475 5475	0.001 0.001 0.001 0.001 0.001 0.001 0.001	3.001E-07 1.954E-06 3.369E-10 2.612E-05 1.416E-09 8.927E-09 1.096E-06 1.684E-09 2.695E-12

(a) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992a).
 (b) Predicted PC (Table 5-7 of U.S. EPA, 1992a).
 (c) Experimentally measured PC value for water, used in the absence of chemical specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).

TABLE S-24 DAILY INTAKE - ADULT SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

		Chemical	Dermal	Skin	Exposure	Exposure	Exposure	Body	Averaging	Conversion	Intake
Chemical		Concentration	Permeability	Surface Area	Frequency	Time	Duration	Weight	Time	Factor	Rate
		(mg/l)	(cm/hr)	(sd cm)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(I/cn cm)	(ma/Ka-dav)
Trichloroethylene	(a)	1.200E-03	0.2	19400	48	2.6	25	70	25550	0.001	8.122E-06
Selenium, dissolved	(q)	3.500E-03	0.001	19400	48	2.6	25	70	25550	0.001	1.185E-07
Carbon Tetrachloride	(q)	8.100E-05	0.022	19400	48	2.6	25	70	25550	0.001	6.031E-08
Tetrachloroethylene	(a)	2.900E-05	0.4	19400	48	2.6	25	70	25550	0.001	3.926E-07
Arsenic	(c)	2.000E-06	0.001	19400	48	2.6	25	70	25550	0.001	6.769E-11
Benzene	(a)	1.551E-03	0.1	19400	48	2.6	25	20	25550	0.001	5.249E-06
Styrene		1.000E-05	0.00084	19400	48	2.6	25	70	25550	0.001	2.843E-10
1,2 Dichlorethane	(q)	1.000E-05	0.0053	19400	48	2.6	25	70	25550	0.001	1.794E-09
1,4 Dichlorobenzene	(q)	1.050E-04	0.062	19400	48	2.6	25	20	25550	0.001	2.203E-07
2 Methylnapthalene	(c)	1.000E-05	0.001	19400	48	2.6	25	70	25550	0.001	3.384E-10
Lead	(a)	4.000E-06	4E-06	19400	48	2.6	25	20	25550	0.001	5.415E-13

(a) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992a).
 (b) Predicted PC (Table 5-7 of U.S. EPA, 1992a).
 (c) Experimentally measured PC value for water, used in the absence of chemical-specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).

TABLE S-25 DAILY INTAKE - CHILD SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

		Chemical	Dermal	SKID	Exposure	Exposure	Exposure	Body	Averaging	Conversion	Intake
Chemical		Concentration	Permeability	Surface Area	Frequency	Time	Duration	Weight	Time	Factor	Rate
		(mg/l)	(cm/hr)	(sd cm)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(I/cn cm)	(ma/Ka-dav)
Trichloroethylene	(a)	1.200E-03	0.2	13300	48	2.6	15	27	25550	0.001	8.662E-06
Selenium, dissolved	(q)	3.500E-03	0.001	13300	48	2.6	15	27	25550	0.001	1.263E-07
Carbon Tetrachloride	(b)	8.100E-05	0.022	13300	48	2.6	15	27	25550	0.001	6.431E-08
Tetrachloroethylene	(a)	2.900E-05	0.4	13300	48	2.6	15	27	25550	0.001	4.187E-07
Arsenic	(c)	2.000E-06	0.001	13300	48	2.6	15	27	25550	0.001	7.218E-11
Benzene	(a)	1.551E-03	0.1	13300	48	2.6	15	27	25550	0.001	5.598E-06
Styrene		1.000E-05	0.00084	13300	48	2.6	15	27	25550	0.001	3.032E-10
1,2 Dichlorethane	(q)	1.000E-05	0.0053	13300	48	2.6	15	27	25550	0.001	1.913E-09
1,4 Dichlorobenzene	(q)	1.050E-04	0.062	13300	48	2.6	15	27	25550	0.001	2.350E-07
2 Methylnapthalene	(c)	1.000E-05	0.001	13300	48	2.6	15	27	25550	0.001	3.609E-10
Lead	(a)	4.000E-06	4E-06	13300	48	2.6	15	27	25550	0.001	5.775E-13

TABLE 8.28 CANCER ESTMATE - DERMAL CONTACT WITH SEDMENTS FUTURE LAND USE SCENARIO - ADULTSICHILDREN

Cardinogenio Effects Site 4, Thrird Fire Training Area, Alpena CRTC, Alpena, Mi

Adult Child Chil	Sec. 1, 1100 110 110 110 110 110 110 110 110	1										Total
Control of the cont		Adu	PIO		SF *	Weight of Fudence	Type of Cancer	Source	Chemical- Spedific Risk	Pathway Risk	Specific	Pathway
2.827E-08 2.100E-08 TES NO FIGURACE B2 Liver IRIS 93 TE-10 1.276E-08 9.479E-09 YES NO DATA C NA 0E+00 3.818E-07 2.836E-07 YES NO DATA C TE-10	Chemical	(mg/kg-day)	(mg/kg-caly)	1	TO TO TO TO TO				0E+00		00440	
	Selectum Methylene chloride	2.827E-08 1.276E-08 3.818E-07	2.100E-08 9.479E-09 2.836E-07		NO EVIDENCE 7.65E-03 NO DATA	B2 C	Liver	IRIS 93 NA	1E-10 0E+00		7E-11 0E+00	
	4-Meulypriero									1E-10		7E-11

^{*} Adusted for administered to absorbed using oral absorption efficiency factors, As=0.95 (ASTDR 1991), Cr=0.11 (ASTDR 1989), MeCl 0.98 (ASTDR 1991)

TABLE 5-27 SUBCHRONC HAZARDOUS INDEX ESTMATE - DERMAL CONTACT WITH SEDMIENTS FUTURE LAND USE SCENARIO - ADULTS/CHILDREN

Noncarcinogeric Effects Ste 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

Ste 4, Into Fire Taining Area, Apena CKTC, Apena, MI	g Area, Alpena CRTC,	Apena, M									
								Adult		PINO	
	Adult	멸	9					Chemical	Total	Chemical	Total
	Ō	G	Adusted for	DE	Oritical		Modfing	Specific	Dathway	Chicara	Daffaran
Chemical	(mg/kg-day)	(mg/kg-day)	Absorption	(mg/kg-day)	Effect	Source	Factor	300	in it	200	Na in way
Selerium	7.915E-08		YES	0.005	Clinical Selenosis	IRIS 93	+	2E.05	uca.	30 00	202
Methylene chloride	3.573E-08		YES	0.0588	liver	[BIS 93	- 41	2013		2000	
4-Methyphenol	1.069E-06	1.324E-06	YES	0.003725	Decreased body weight	HEAST 83	- •	35.04		45-04	
								;			
RO											

^{*} Adusted for administered to absorbed using oral absorption efficiency factors, As=0.95 (ASTDR 1991), Cr=0.11 (ASTDR 1989), MeCl 0.98 (ASTDR 1991), Se 0.935 (ASTDR 1989), 4-Metryphenal 0.745 (ASTDR 1992)

TABLE 3-28 CANCER ESTIMATE - SEDIMENT INCESTION FUTURE LAND USE SCENARIO - ADULTS/CHILDREN

Ste 4, Third Fire Trainin	Site 4, Third Fire Training Area, Alpena CRTC, Alpena, Mi	pena, MI						Adut	DINO	
	Adult	PIG :	CDI Adusted for	SF Contract column	Weight of Expense	Type of Cancer	Source	Specific Rask	Spedific	Pathway
hemical elenium eletrylene chloride	(mg/kg-day) 3.271E-08 5.906E-10 1.767E-08	(mg/kg-cay) 7.327E-08 1.323E-09 3.958E-08	ON ON	NO EVIDENCE 0.0075 NO DATA	B2 C	Liver	IRIS 93 NA	0E+00 4E-12 0E+00	0E+00 1E-11 0E+00	
Med lyptica ka									4E-12	1E-1

1) Converted from a unit risk of 5 X 10E-05 ug/L given in IRIS.

TABLE 5.29 SUBCHRONC HAZARDOUS INDEX ESTMATE SEDMENT INGESTION FUTURE LAND USE SCENARIO - ADULTS/CHILDREN

								Adult	PILO	
				Subdranic				Chemical-	Chemical-	Total
	Adult	PIEO	O O	RfD	Critical	£	ModfMng	Spediic	Specific	Pathway
	8	0	Adusted for	(mg/kg-day)	Effect	Source	Factor	- N	Risk	T.
mical	(mg/kg-day)	(mg/kg-day)	Absorption							
nium	9.158E-08	8.548E-07	ON	0.005	Cirical selenosis	IRIS 93	-	2E-05	2E-04	
nyene chloride	1.654E-09	1.543E-08	ON	90:00	Liver	IRIS 93	-	3F-08	3F-07	
ethylphenol	4.948E-08	4.618E-07	ON	0.005	Decreased body weight	HEAST 83		1E-05	9E-05	

SITE4.WB1/940127

TABLE S-30 CANCER ESTIMATE - FISH INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

	סאפר, ווווער וויפ וומווווען אינען אינען אינען	10000						Adult	Total	Children Chemical-	Total
		Child	CDI Adjusted for	SP	Weight of	Type of Cancer	SP	Specific	Pathway Risk	Specific Risk	Pathway Risk
Chemical	(mg/kg-day) 4 592E-07	(mg/kg-day) 5.688E-07	Absorption (mg/kg-day) - 1	0.01	B2	Lung	CA EPA 92 (1)	5E-09		6E-09	
Selenium, dissolved	3.434E-08	4.254E-08	NO NO EV	DENCE		AN.		201			
		!		,	ć	Hentocellular carcinomas	IRIS 93	2E-09		2E-09	
Carbon Tetrachloride	1.351E-08	1.674E-08	2 :	0.13	20	INP	CA EPA 92	8E-10		1E-09	
Tetrachloroethylene	1.594E-08	1.974E-08	2 5	100.0	79	Dati Ling	IRIS 93	4E-11		4E-11	
Arsenic	1.963E-11	2.431E-11	D.	9.1.6	٤ <	i outomia	IRIS 93	1E-08		1E-08	
Benzene	3.653E-07	4.525E-07	0	670.0	()		₹Z	0F+00		0E+00	
Styrene	9.813E-09	1.215E-08	0	ODALA	4 00	Semonacioned .	IRIS 93	2E-11		2E-11	
1.2 Dichlorethane	1.963E-10	2.431E-10	NO 0.091	0.091	82	Liver famore	HFAST 93	1E-09		2E-09	
1,4 Dichlorobenzene	6.182E-08	7.658E-08	ON !	0.024	2	NA	AN	0E+00		0E+00	
2 Methylnapthalene	5.004E-08	6. 199E-08	NO NO EV	MUENCE	X C	Ventrix	Y Z	0E+00		0E+00	
Lead	3.925E-09	4.862E-09	9	NO DATA	79	(a)					
									2E_08		2E-08

TABLE S-31 CHRONIC HAZARDOUS INDEX ESTIMATE - FISH INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

	******	70	Č					Adult		Children	
	Adult		CO	í	3	!!		Chemical-	Total	Chemical-	Tota
0	CDI	מסו	Adjusted for	. KED	Critical	RfD	Modifying	Specific	Pathway	Specific	Pathway
Chemical	(mg/kg-day)	(mg/kg-day)	Absorption	(mg/kg-day)	Effect	Source	Factor	Risk	Risk	Risk	Ris
Trichloroethylene	1.286E-06	2.655E-06	02	0.00735	Red blood cells	CA EPA 92	-	2E-04		4E-04	
Selenium, dissolved	9.616E-08	1.985E-07	ON	0.005	Clinical Selenosis	IRIS, 1993	-	2E-05		4E-05	
Carbon Tetrachloride	3.783E-08	7.811E-08	O _N	0.0007	Liver Lesions	IRIS, 1993	-	5E-05		1E-04	
Tetrachloroethylene	4.462E-08	9.212E-08	ON N	0.01	Hepatotoxicity	IRIS, 1993	-	4E-06		9E-06	
Arsenic	5.495E-11	1.134E-10	ON.	0.0003	Keratosis	IRIS, 1993	-	2E-07		4E-07	
Benzene	1.023E-06	2.111E-06	9	No Data	Y.A	ΨZ	AN				
Styrene	2.748E-08	5.672E-08	<u>Q</u>	0.2	Red blood cell and liver	IRIS, 1993	-	1E-07		3E-07	
1,2 Dichlorethane	5.495E-10	1,134E-09	9	No Data	NA	Ϋ́Z	4 Z				
1,4 Dichlorobenzene	1.731E-07	3.574E-07	ON	No Data	NA	NA.	AN				
2 Methylnapthalene	1.401E-07	2.893E-07	9	0.03	NA	٧×	42	5E-06		1E-05	
Lead	1.099巨-08	2.269E-08	Q	No Data	NA	AN	NA				

1) RfD calculated from conversion of 1.3 mg/L drinking water standard.

TABLE S:32 CANCER ESTIMATE - SURFACE WATER INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI	na CRTC, Alpens	a, MI						Adult	1	Children	Total
	Adult	CDI	CDI Adjusted for	SF	Weight of	Type of	RS	Chemical- Specific Risk	lotal Pathway Risk	Specific	Pathway
Chemical Trichloroethylene	(mg/kg-day) 4.201E-08	(mg/kg-day) 4.592E-07 3.434F-08	Absorption NO NO	(mg/kg-day)^1 0.01 NO EVIDENCE	Evidence B2	Lung	CA EPA 92 (1)	4E-10 0E+00		5E-09 0E+00	
Selentum, dissolved Carbon Tetrachloride Arsanic Benzene 8-1.2 Dichlorethane 1.4 Dichlorethane 1.4 Dichlorethane 1.5 Methylnapthalene	7.065E-09 2.529E-09 1.744E-10 1.353E-07 8.722E-10 8.722E-10 9.199E-09 8.722E-10 3.489E-10		222222222	0.13 0.051 1.8 0.029 NO DATA 0.091 NO EVIDENCE NO DATA	8 4 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	Heptocellular carcinomas Liver Skin, Lung Leukemia NA Hemangiosarcomas Liver tumors NA Kidney	IRIS 93 CA EPA 92 IRIS 93 IRIS 93 IRIS 93 Heat 93 Heat 93 NA	9E-10 1E-10 3E-10 4E-09 0E-40 8E-11 2E-10 0E+00		1E-09 2E-10 5E-10 6E-09 0E-40 1E-10 3E-10 0E+00	
									6F-09		1E-08

(a)Converted from a unit risk of 5e-5 ugl given in IRIS (b) no SF exists for styrene as of 1/5/84. Classified as probable carcinogen by IRAC 1) Data from Cr +6 was used.

TABLE S-33 CHRONIC HAZARDOUS INDEX ESTIMATE - SURFACE WATER INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI	rea, Alpena CRTC, Alpen	IM, bu									
Chemical	Adult CDI (mg/kg-day)	Child CDI (mg/kg-day)	CDI Adjusted for Absorption	RfD (mg/kg-day)	Critical Effect	RID	Modifying	Adult Chemical- Specific	Total Pathway	Children Chemical- Specific	Total
Trichloroethylene Selenium, dissolved	1.176E-07 5.129E-07	3.049E-07 1.330E-06	0 0	0.00735	Red blood cells Clinical Selenosis	CA EPA 92 IRIS, 1993	1	2E-05 1E-04	NISK	AE-05 3E-04	XIX
Carbon Tetrachloride Arsenioetrylene Arsenie Benzene Styrene 1,2 Dichlorethane 1,4 Dichlorethane 2 Metrylnaptrialene	1.978E-08 7.083E-09 4.885E-10 3.788E-07 2.442E-09 2.564E-08 2.564E-08 2.564E-08 2.564E-09 9.769E-10	5 129E-08 1.836E-08 1.266E-09 9.821E-07 6.332E-09 6.432E-08 6.648E-08 6.332E-09 2.533E-09	22222222	0 0007 0 01 0 001 0 003 NA NO A 0 2 No Data 0 03	Liver Lesions Hepatotoxicity Reatotosis NA Red blood cell and liver NA NA NA	IRIS, 1993 IRIS, 1993 IRIS, 1993 NA IRIS, 1993 NA NA NA	4-444444444444444444444444444444444	3E-05 7E-07 2E-06 1E-08 8E-08		7E-05 2E-06 4E-06 3E-08	
Total									į		į

TABLE S-34 CANCER ESTIMATE - SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Adult Child							Adult		College	
3	Child	CDI Adjusted for	H.S.	Weight of	Type of Cancer	Source	Chemical- Specific Risk	Total Pathway Risk	Chemical- Specific Risk	Total Pathway Risk
Chemical (mg/kg-day) Trichloroethyliene 8.122E-06 Selenium, dissolved 1.185E-07	(mg/kg-day) 06 8.662E-06 07 1.263E-07	Absorption YES YES	Absorption (mg/Kg-day)*-1 YES 1.76E-02 YES NO EVIDENCE	B2	Lung NA	CA EPA 92 (1)	1E-07 0E+00 0E+00		2E-07 0E+00 0E+00	
Carbon Tetrachloride 6 031E-08 Tetrachloroethylene 3 926E-07 Arsenic 6 769E-11 Benzene 5 249E-06 Styrene 2 843E-10 1,2 Dichlorethane 1 794E-09 1,4 Dichlorobenzene 2 203E-07 2 Metrylnapthalene 3:384E-10 Lead 5 415E-13	08 6 431E-08 07 4 187E-07 11 7.218E-11 06 5.598E-06 10 3.032E-10 09 1913E-09 10 3.609E-10 11 3.609E-10 11 3.609E-10 12 3.609E-10 13 6.775E-13	Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y	1.44E-01 0.051 1.89E-00 0.029 NO DATA 0.091 0.024 NO EVIDENCE NO DATA	87 × × P B B S S S S S S S S S S S S S S S S S	Heptocellular carcinomas Skin, Lung Leukemia N A Hemangiosarcomas Liver tumors NA Kloney	RAS 93 CA EPA 92 RAS 93 RAS 93 RAS 93 NA RAS 93 heast 93 NA NA	9F.09 2F.08 1F.10 2F.07 0E+00 5F.09 0E+00 0E+00		2E-08 2E-08 1E-10 2E-07 0E+00 2E-10 6E-09 0E+00	
								3E-07		4E-07

[•] Adjusted from administered to absorbed dose by assuming the following oral absorption efficiences: Se 0.935 (ASTDR, 1989), As 0.95 (ASTDR(1991), CCI4 0.9 (ASTDR, 1992), PCE 1.0 (ASTDR 1990), Benzene 1.0 (ASTDR 1989), Styrene 1.0 (defauit), TCE 0.85 (defauit) 1.4, DCB 1.0 (ASTDR 1991).

TABLE S-35 CHRONIC HAZARDOUS INDEX ESTIMATE - SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncarcinogenic Effects Site 4, Third Fire Training Area, Alpena CRTC, Alpena, MI

								Adult		Children	
	Adult	Child	CDI					Chemical-	Total	Chemical-	Total
	CDI		Adjusted for	RID	Critical	Oly Oly	Modifying	Specific	Pathway	Specific	Pathway
Chemical	(mg/kg-day)	(mg/kg-day)	Absorption	(mg/kg-day)	Effect	Source	Factor	Risk	Risk	Risk	Risk
Trichforoethylene	2.274E-05		YES	0.85	Red blood cells	CA EPA 92		3E-05		5F-05	
Selenium, dissolved	3.317E-07	5.895E-07	YES	0.004675	Clinical Selenosis	IRIS, 1993	-	7E-05		1E-04	
Carbon Tetrachloride	1.689E-07	3.001E-07	YES	0.00063	Liver Lesions	IRIS. 1993	-	3F-04		5E-04	
Tetrachloroethylene	1.099E-06	1.954E-06	YES	0.01	Hepatotoxicity	IRIS 1993	-	1E-04		2F-04	
Arsenic	1.895E-10	3.369E-10	YES	0.000285	Keratosis	IRIS 1993	-	7F-07		1E-06	
Benzene	1.470E-05	2.612E-05	YES	No Data	AN	AZ.	NA	1)	
Styrene	7.960E-10	1.415E-09	YES	0.2	Red blood cell and liver	IRIS 1993	-	4F-09		7F_09	
1,2 Dichlorethane	5.022E-09	8.927E-09	YES	No Data	AZ	d'Z	. 4N			3	
I,4 Dichlorobenzene	6.169E-07	1.096E-06	YES	No Data	₹Z	A Z	AN N				
2 Methylnapthalene	9.476E-10	1.684E-09	YES	0 03	AN	AN.	AN	3F-08		6F-08	
Lead	1.516E-12	2.695E-12	YES	No Data	NA	ĄN	A N				
									5E-04		8E-04

* Adjusted from administered to absorbed dose by assuming the following oral absorption efficiences: Se 0.935 (ASTDR, 1981), AS 0.95 (ASTDR(1991), CCI4 0.9 (ASTDR, 1992), PCE 1.0 (ASTDR 1990), Benzene 1.0 (ASTDR 1989), Styrene 1.0 (default), TCE 0.85 (default) 1.1, DCE 1.0 (default), 1.1, DCB 1.0 (ASTDR 1991).

1) RID calculated from conversion of 1.3 mg/L drinking water standard.

Groundwater Solute Transport Model Data - Site 4

Theoretical Background

A two-dimensional Method of Characteristics (MOC) solute transport model (Konikow and Bredehoeft, 1989) was used for preliminary examination of contaminant migration within the shallow aquifer beneath the Alpena CRTC. The model is designed to calculate transient changes in solute concentrations within groundwater by simultaneously solving partial differential equations describing groundwater flow and transport and computes the change in a chemicals concentration over time. Changes in chemical concentrations over time are caused by the processes of convective transport, hydrodynamic dispersion, and mixing from fluid sources. This model couples the groundwater flow equation with solute transport equations.

The flow equation can be approximated by an implicit finite-difference equation. The model area is discretized into a rectangular grid with each square being a node. The finite difference equation is solved numerically for each node in the grid using an iterative alternating-direction implicit (ADI) procedure.

After the hydraulic head distribution is calculated, the velocity of groundwater flow can be computed at each node. The expression for average velocity of groundwater can be derived from Darcy's law. The groundwater velocity at each node is calculated utilizing an explicit finite-difference approximation of Darcy's law. The computer program uses an alternating-direction implicit procedure to solve a finite-difference approximation to the groundwater flow equation, and it uses the method of characteristics (MOC) to solve the solute transport equation. MOC uses a particle tracking procedure to represent convective transport and a two-step, explicit procedure to solve a finite-difference equation that describes the effects of hydrodynamic dispersion, fluid sources and sinks, and divergence of velocity.

A number of assumptions are inherent in the solute transport model:

- Darcy's law is valid and hydraulic head gradients are the only significant driving mechanism for fluid flow.
- The porosity and hydraulic conductivity of the aquifer are constant with time, and porosity is uniform in space.
- 3. Gradients of fluid density, viscosity, and temperature do not affect the velocity distribution.
- No chemical reactions occur that affect the concentration of the solute, the fluid properties, or the aquifer properties.
- 5. Ionic and molecular diffusion are negligible contributors to the total dispersive flux.

- 6. Vertical variations in head and concentrations are negligible.
- 7. The aquifer is homogeneous and isotropic with respect to the coefficients of longitudinal and transverse dispersivity.

Transport Model Input

A model grid of 32 columns by 19 rows with a 250 foot lateral spacing was used. Specified head cells were used at nodes corresponding to the South Branch of the Thunder Bay River, at nodes along the eastern boundary of the model grid area, and also at the sinkhole in the northeastern portion of the model. Groundwater elevations measured during September, 1993 were used as initial input into the transport model. Hydraulic conductivity values were calculated from slug tests performed at Alpena CRTC (Engineering Science, 1989; Earth Technology, 1994). Values of hydraulic conductivity range from 12 feet/day at Site 4 to 278 feet/day at Site 3.

Aquifer thickness values were obtained from drilling records of monitoring wells and soil borings obtained from the SI and RI field activities. Values listed are from logs in which the thickness of the shallow aquifer was clearly discernible, and ranged from 20 feet at Site 5 to 65 feet at Site 8. Transmissivity values were calculated by multiplying the calculated hydraulic conductivity values by the aquifer thickness. Transmissivity ranges from 420 ft²/day at TF4-MW3 to 15,290 ft²/day at CG3-MW5.

Monitoring of the discharge of springs into the sinkhole was performed during the SI (Engineering Science, 1990) and an estimate of approximately 18,000 gallons of water per day discharging into the sinkhole was calculated. In order to obtain a numerical estimate of discharge into the sinkhole for the model, MODFLOW (McDonald and Harbaugh, 1988), a 3- dimensional finite-difference groundwater flow model was used. MODFLOW was used because of its ability to simulate the effect of head-dependent groundwater flow into a groundwater sink (i.e. the sinkhole). This package was not available in MOC. The same model parameters and boundary conditions were used within MODFLOW as in MOC. Based upon hydraulic head data collected in September 1993, discharge from the shallow aquifer into the sinkhole is approximately 30,000 gallons per day.

The dispersivity of an aquifer in two dimensions is described by the longitudinal dispersion, the transverse dispersion and the ratio of the two (Fetter, 1993). As a contaminant plume moves further from its initial location within the aquifer by advection with the groundwater flow, the plume spreads. The spreading in the direction of groundwater flow is the longitudinal dispersion, the spreading in the direction perpendicular to the groundwater flow is known as the transverse dispersion (Fetter, 1993). The values of the dispersion coefficients are typically derived via bench scale tests, aquifer tests, or calibration of contaminant transport models. Since no data presently exists describing dispersivity within the shallow aquifer beneath the Alpena CRTC and insufficient data exists to allow for derivation of dispersivity via model calibration, moderate values of 100 feet for longitudinal dispersivity and 30 feet for transverse dispersivity were chosen (Gillham and

Cherry, 1982). A more complete description of the model is given in the report, Preliminary Groundwater Modeling Effort, Earth Technology, August 1993.

Model Calibration:

The groundwater flow model was calibrated with respect to the September 1993 groundwater elevation measurements. Calibration of the groundwater flow model was accomplished by defining a set of parameters, boundary conditions, and stresses that produce simulated heads and fluxes that match field-measured values within a preestablished range of error (Anderson and Woessner, 1992). In order to match field measured values for hydraulic head as determined during September 1993, a few modifications were made to the preexisting groundwater flow model. These changes included updating the initial head array, modeling the sinkhole as a constant head cell to account for the large gradient changes in the vicinity of the sinkhole and including recharge to the model at a rate of 9 inches per year over the whole model area. By adjusting these parameters, an acceptable level of calibration was achieved. An acceptable level of calibration was defined as a root mean squared error (RMS) of less than 2 feet. The RMS, or the standard deviation is the average squared difference in measured and simulated heads and is given by the equation:

RMS=
$$[1/n\sum_{i=1}^{n} (h_m - h_s)_i^2]^{0.5}$$

n = number of wells $h_m = measured head$ $h_s = model simulated head$

Certain portions of the model may have values above the goal of 2 feet while others fall much below this value. The RMS represents the average error present in the model. The following provides a summary of the final calibrated heads for the flow model.

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
MP2MW1	10,25	679.69	676.68	3.01
MP2MW3	10,22	675.51	675.46	0.05
MP2MW4_5*	11,23	675.34	675.70	-0.36
MP2MW6	11,20	674.86	674.52	0.34
CG3MW1	6,24	677.38	676.69	0.69
CG3MW2	7,22	676.29	675.78	0.51

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
свзммз	9,23	676.50	675.98	0.52
CG3MW4_5*	8,23	676.41	676.08	0.33
CG3MW7	8,20	675.64	674.80	0.84
TF4MW1	7,9	667.23	668.83	-1.60
TF4MW2	8,10	659.61	664.22	-4.61
TF4MW3_4*	9,10	658.21	660.06	-1.85
SF5MW1	12,6	674.15	671.34	2.81
SF5MW2	14,5	675.32	672.67	2.65
SF5MW3_4*	13,6	676.46	671.64	4.82
SF5MW6	13,5	674.26	672.40	1.86
LF6MW1	14,9	672.1	670.40	1.70
LF6MW2	14,8	672.68	670.72	1.96
LF6MW3	14,10	671.93	670.21	1.72
LF6MW4	16,7	672.75	671.91	0.84
LF6MW5	15,7	673.07	671.56	1.51
LF6MW6	13,10	671.17	669.67	1.50
LF6MW8	15,9	673.12	670.78	2.34
HN8MW1	5,22	676.96	675.93	1.03
HN8MW2	6,19	675.31	674.50	0.81
HN8MW3_4*	7,21	676.01	675.35	0.66
RT9MW1	6,16	673.06	672.78	0.28
RT9MW2	7,14	668.21	670.81	-2.60
RT9MW3	9,15	670.72	671.26	-0.54
RT9MW4_5*	8,14	667.47	670.32	-2.85
RT9MW6	8,16	670.58	672.33	-1.75
S1MW2	13,26	677.39	676.63	0.76

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
S1MW3	13,27	677.15	676.98	0.17
S1MW11	15,24	675.72	675.67	0.05
S1MW12	16,25	674.55	675.94	-1.39
S1MW13	14,24	675.21	675.76	-0.55
S1MW14	14,25	673.92	676.14	-2.22
MP2MW2	12,24	675.57	675.96	-0.39

^{*} Indicates that more than one well is present in each node and an average value for hydraulic head was used.

Sum of Squared Residuals = 128.78/38 = 3.3891 Root Mean Squared Error = 1.84

It should also be noted that the model was calibrated with respect to the September 1993 water level data and should only be considered calibrated with respect to this data. More information on the water level fluctuation through time would be needed to perform a transient calibration. The model was not calibrated with respect to concentration data, but only with respect to hydraulic head.

Model Assumptions and Limitations

- * The model domain consisted only of the shallow unconfined aquifer (i.e. one layer).
- * The initial head data input to the transport model are results of measurements taken in September 1993.
- * Initial concentrations of compounds are results of the Round IV sampling event which was conducted from July to September 1993.
- * Hydraulic conductivity values are the result of slug tests performed in November, 1987 and September 1993.
- * The model was calibrated with respect to hydraulic head using September 1993 water level data and should only be considered calibrated with respect to September 1993 water level data.
- * The flow model was assumed to be at steady-state with respect to hydraulic head.

Site 4

No organic compounds were present in the groundwater at Site 4 above Act 307 Type B cleanup criteria. However, model simulations predict that contaminants from sites 2, 5, 6, 8, and 9 would reach the sinkhole after a period of several years with maximum concentrations entering the sinkhole between 5 and 20 years depending on which site the contaminants originate from. PCE, arsenic, and carbon tetrachloride originating from wells MP2MW7, MP2MW1 and PW3 at Site 2 arrive at the sinkhole in concentrations ranging from 0.002 (arsenic) to 0.28 ug/l for PCE. The chemicals 1,2 -DCA, 1,4 -DCB, benzene and styrene originating from well SF5MW1 at Site 5 arrive at the sinkhole at concentrations ranging from 0.01 (styrene) and 1.55 ug/l for benzene. Well LF6MW3 at Site 6 contained carbon tetrachloride which arrived at the sinkhole at an estimated concentration of 0.08 ug/l. Well HN8MW3 at Site 8 contained PCE which arrived at the sinkhole with an estimated concentration of 0.001 ug/l. Well RT9MW6 at Site 9 contained PCE, benzene, 1,4 -DCB, lead, and 2-methylnapthalene which arrived at the sinkhole at concentrations ranging from 0.001 (PCE) to 0.01 ug/l for 2-methylnapthlene.

Appendix T: Site 5 Risk Assessment

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Groundwater - Site 5 MIANG, Alpena CRTC, Alpena, MI Table T-1A

SITE	LOCATOR	SAMPLE ID	MATRIX	ANALYTE	RESULT
PC-SF5	MW1	PC-SF5-MW1-GW4	GROUNDWATER	1,2-Dichloroethane	0.1250
PC-SF5	MW2	PC-SF5-MW2-GW4	GROUNDWATER	1,2-Dichloroethane	0.1250
PC-SF5	MW3	PC-SF5-MW3-GW4	GROUNDWATER	1,2-Dichloroethane	0.1250
PC-SF5	MW4	PC-SF5-MW4-GW4	GROUNDWATER	1,2-Dichloroethane	0.1250
PC-SF5	MW5	PC-SF5-MW5-GW4	GROUNDWATER	1,2-Dichloroethane	0.1250
PC-SF5	MW6	PC-SF5-MW6-GW4	GROUNDWATER	1,2-Dichloroethane	0.1250
PC-SF5	MW7	PC-SF5-MW7-GW4	GROUNDWATER	1,2-Dichloroethane	0.1250
PC-SF5	MW8	PC-SF5-MW8-GW4	GROUNDWATER	1,2-Dichloroethane	0.4400
PC-SF5	WW9	PC-SF5-MW9-GW4	GROUNDWATER	1,2-Dichloroethane	0.1250
PC-SF5	MW1	PC-SF5-MW1-GW4	GROUNDWATER	1,4-Dichlorobenzene	3.5000
PC-SF5	MW2	PC-SF5-MW2-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-SF5	MW3	PC-SF5-MW3-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-SF5	MW4	PC-SF5-MW4-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-SF5	MW5	PC-SF5-MW5-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-SF5	MW6	PC-SF5-MW6-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-SF5	MW7	PC-SF5-MW7-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-SF5	6MM	PC-SF5-MW9-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-SF5	MW1	PC-SF5-MW1-GW4	GROUNDWATER	Benzene	52.0000
PC-SF5	MW2	PC-SF5-MW2-GW4	GROUNDWATER	Benzene	0.1750
PC-SF5	MW3	PC-SF5-MW3-GW4	GROUNDWATER	Benzene	0.1750
PC-SF5	MW4	PC-SF5-MW4-GW4	GROUNDWATER	Benzene	0.1750
PC-SF5	MW5	PC-SF5-MW5-GW4	GROUNDWATER	Benzene	0.1750
PC-SF5	MW6	PC-SF5-MW6-GW4	GROUNDWATER	Benzene	0.1750
PC-SF5	MW7	PC-SF5-MW7-GW4	GROUNDWATER	Benzene	0.1750
PC-SF5	MW8	PC-SF5-MW8-GW4	GROUNDWATER	Benzene	41.0000
PC-SF5	6MM	PC-SF5-MW9-GW4	GROUNDWATER	Benzene	0.2600
PC-SF5	MW1	PC-SF5-MW1-GW4	GROUNDWATER	Styrene	1.5000
PC-SF5	MW2	PC-SF5-MW2-GW4	GROUNDWATER	Styrene	0.1250
PC-SF5	MW3	PC-SF5-MW3-GW4	GROUNDWATER	Styrene	0.1250
PC-SF5	MW4	PC-SF5-MW4-GW4	GROUNDWATER	Styrene	0.1250
PC-SF5	MW5	PC-SF5-MW5-GW4	GROUNDWATER	Styrene	0.1250
PC-SF5	MW6	PC-SF5-MW6-GW4	GROUNDWATER	Styrene	0.1250
PC-SF5	MW7	PC-SF5-MW7-GW4	GROUNDWATER	Styrene	0.1250
PC-SF5	MW8	PC-SF5-MW8-GW4	GROUNDWATER	Styrene	0.6700
PC-SF5	6MM	PC-SF5-MW9-GW4	GROUNDWATER	Styrene	0.1250

TABLE T-1 EXPOSURE ASSESSMENT PARAMETERS - FISH INGESTION Site 5, Second Fire Training Area, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	CHILD	
Fraction of Fish Ingested, unitless	50	0.5	
Ingestion rate kg/day	0.054	0.043	
Exposure Frequency days/yr	56	26	
Exposure Duration (years)	25	15	
Body Weight, Kg	20	27	
Averaging Time			
Carcinogens	02	20	
Noncarcinogens	25	15	

FUTURE LAND USE SCENARIO T-2 DAILY INTAKE - ADULT FISH INGESTION TABLE

Noncarcinogenic Effect Exposure Assessment Site 5, Second Fire Training Area, Alpena CRTC, Alpena, MI

		1 - 14 0				- Pool	Assessment	Japan
	Chemical	Ingestion		Fraction	exposite	hood	Averaging	HIGHE
Chemical	Concentration	Rate		Ingested	Duration	Weight	Time	Rate
	(mg/kg)	(kg/day)	(days/year)	(unitless)	(years)	(kg)	(days)	(mg/Kg-day)
Styrene	1.000E-03	0.054		0.5	25	20	9125	2.748E-08
Benzene	3.600E-02	0.054		0.5	25	2	9125	9.891E-07
1 4-Dichlorobenzene	6.000E-03	0.054	26	0.5	25	2	9125	1.649E-07
1.2-Dichloroethane	2.000E-02	0.054		0.5	25	20	9125	5.495E-07

FUTURE LAND USE SCENARIO T-3 DAILY INTAKE - CHILD FISH INGESTION TABLE

Noncarcinogenic Effect Exposure Assessment Site 5, Second Fire Training Area, Alpena CRTC, Alpena, MI

T-3

Exposure Duration 0.5 0.5 0.5 Fraction Ingested (unitless) Exposure Frequency 8888 (days/year) (kg/day) 0.043 0.043 0.043 Ingestion Rate (mg/kg) 1.000E-03 3.600E-02 6.000E-03 2.000E-02 Chemical Concentration Styrene Benzene 1,4-Dichlorobenzene 1,2-Dichloroethane Chemical

(mg/Kg-day) 5.672E-08 2.042E-06 3.403E-07 1.134E-06

(days) 5475 5475 5475 5475

Body Weight (kg) 27 27 27 27

(years) 15 15 15

Rate

Averaging Time

TABLE T.4 DAILY INTAKE - ADULT FISH INGESTION FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 5, Second Fire Training Area, Alpena CRTC, Alpena, MI

	200	anistra and		i de ca		0	Acceptant	- Judani
	Clelincal	Highestion		רומכווטו	Exposite	pody	Averaging	IIIake
Chemical	Concentration	Rate	Frequency	Ingested	Duration	Weight	Time	Rate
	(mg/kg)	(kg/day)	_	(unitless)	(years)	(kg)	(days)	(mg/Kg-day
Styrene	1.000E-03	0.054		0.5	25	02	25550	9.813E-09
Benzene	3.600E-02	0.054		0.5	25	20	25550	3.533E-07
1,4-Dichlorobenzene	6.000E-03	0.054	56	0.5	25	20	25550	5.888E-08
1,2-Dichloroethane	2.000E-02	0.054	56	0.5	25	20	25550	1.963E-07

TABLE T-6 DAILY INTAKE - CHILD FISH INGESTION FUTURE LAND USE SCENARIO Carcinogenic Effect Exposure Assessment

Chemical Chemical Ingestion Exposure Fraction Exposure Body Averaging Intake Concentration Rate Frequency Ingested Duration Weight Time Rate Styrene 1.000E-03 (kg/day) (days)/vear) (unitless) (years) (kg) (days) (mg/Kg-day) Styrene 1.000E-03 0.043 26 0.5 15 27 2550 1.215E-08 3.600E-02 0.043 26 0.5 15 27 25550 4.376E-07 1,4-Dichlorobenzene 6.000E-03 0.043 26 0.5 15 27 25550 7.293E-08 1,2-Dichloroethane 2.000E-02 0.043 26 0.5 15 27 25550 2.431E-07									
Concentration Rate (mg/kg) (Frequency (days/year) (unitless) Indicated (vears) Weight (vears) Time (vears) 1.000E-03 0.043 26 0.5 15 27 25550 3.600E-02 0.043 26 0.5 15 27 25550 6.000E-03 0.043 26 0.5 15 27 25550 2.000E-02 0.043 26 0.5 15 27 25550 2.000E-02 0.043 26 0.5 15 27 25550		Chemical	Ingestion	Exposure	Fraction	Exposure	Body	Averaging	Intake
(mg/kg) (kg/day) (days/year) (unitless) (years) (kg) (days) (days) (governorm) 1.000E-03 0.043 26 0.5 15 27 25550 Iorobenzene 6.000E-03 0.043 26 0.5 15 27 25550 Ioroethane 2.000E-02 0.043 26 0.5 15 27 25550	Chemical	Concentration	Rate	Frequency	Ingested	Duration	Weight	Time	Rate
1.000E-03 0.043 26 0.5 15 27 25550 3.600E-02 0.043 26 0.5 15 27 25550 loroethane 2.000E-02 0.043 26 0.5 15 27 25550		(mg/kg)	(kg/day)	(days/year)	(unitless)	(years)	(kg)	(days)	(mg/Kg-day)
3.600E-02 0.043 26 0.5 15 27 25550 6.000E-03 0.043 26 0.5 15 27 25550 2.000E-02 0.043 26 0.5 15 27 25550	Styrene	1.000E-03	0.043	26	0.5	15	27	25550	1.215E-08
6,000E-03 0.043 26 0.5 15 27 25550 2.000E-02 0.043 26 0.5 15 27 25550	Benzene	3.600E-02	0.043	26	0.5	15	27	25550	4.376E-07
2.000E-02 0.043 26 0.5 15 27 25550	1,4-Dichlorobenzene	6.000E-03	0.043	26	0.5	15	27	25550	7.293E-08
	1,2-Dichloroethane	2.000E-02	0.043	26	0.5	15	27	. 25550	2.431E-07

TABLE T-6 CANCER ESTIMATE - FISH INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

5, Second Fire I	Site 5, Second Fire training Alea, Aperia Chile, Apolia, IIII	C, Apena, MI						Adult		Children	
	:		3					Chemical-	Total	Chemical-	Total
	Adult	S G	Adhinted for	ŭ.	Wetaht of	Type of	SF	Specific	Pathway	Specific	Pathway
	IO.	5	•	The decide of	Eldonco	Cancer	Source	Risk	Risk	Risk	RISK
	(mg/kg-day)	(mg/kg-day)	Absorption (mg/kg-d	g/kg-dayy	CMCCICC			0E+00		0E+00	
	9.813E-09	1,215E-08		LAIDENCE	•	elmodi to I	IRIS 1993	1F-08		1E-08	
	3.533E-07	4.376E-07	2	0.029	₹ 1	Leurenina the Temper	UEACT 03	2F.09		2E-09	
4 Mchlorobenzene	5.888E-08	7.293E-08	2	0.029	٥	Liver Turnors	2017	00 10		30 30	
2-Dichlorooffrans	1.963E-07	2.431E-07	ON	0.13	B2	Hemaglosarcomas	IKIS, 1993	35-08	4E 00	35-76	SE-DR

TABLE 1-7 CHRONIC HAZARDOUS INDEX ESTIMATE - FISH INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncarcinogenic Effects Site 5, Second Fire Training Area, Apena CRTC, Apena, MI

								Adult		Children	
A	Adult	Child	O O					Chemical-	Total	Chemical-	Total
)	CDI	CDI	Adjusted for	RfD	Critical	Cl.N	Modifying	Specific	Pathway	Specific	Pathway
(mg/)		mg/kg-day)		(mg/kg-day)	Effect	Source	Factor	Risk	Risk	Risk	Risk
2		5.672E-08		0.2		IRIS, 1993		1E-07		3E-07	
6		2.042E-06	ON	NO DATA							
-	1.649E-07	3.403E-07	NO	NO DATA	Ą						
10		1.134E-06	ON	NO DATA	ĄN						

SITE5C.WB1/ 940127

Groundwater Solute Transport Model Data - Site 5

Theoretical Background

A two-dimensional Method of Characteristics (MOC) solute transport model (Konikow and Bredehoeft, 1989) was used for preliminary examination of contaminant migration within the shallow aquifer beneath the Alpena CRTC. The model is designed to calculate transient changes in solute concentrations within groundwater by simultaneously solving partial differential equations describing groundwater flow and transport and computes the change in a chemicals concentration over time. Changes in chemical concentrations over time are caused by the processes of convective transport, hydrodynamic dispersion, and mixing from fluid sources. This model couples the groundwater flow equation with solute transport equations.

The flow equation can be approximated by an implicit finite-difference equation. The model area is discretized into a rectangular grid with each square being a node. The finite difference equation is solved numerically for each node in the grid using an iterative alternating-direction implicit (ADI) procedure.

After the hydraulic head distribution is calculated, the velocity of groundwater flow can be computed at each node. The expression for average velocity of groundwater can be derived from Darcy's law. The groundwater velocity at each node is calculated utilizing an explicit finite-difference approximation of Darcy's law. The computer program uses an alternating-direction implicit procedure to solve a finite-difference approximation to the groundwater flow equation, and it uses the method of characteristics (MOC) to solve the solute transport equation. MOC uses a particle tracking procedure to represent convective transport and a two-step, explicit procedure to solve a finite-difference equation that describes the effects of hydrodynamic dispersion, fluid sources and sinks, and divergence of velocity.

A number of assumptions are inherent in the solute transport model:

- 1. Darcy's law is valid and hydraulic head gradients are the only significant driving mechanism for fluid flow.
- 2. The porosity and hydraulic conductivity of the aquifer are constant with time, and porosity is uniform in space.
- 3. Gradients of fluid density, viscosity, and temperature do not affect the velocity distribution.
- 4. No chemical reactions occur that affect the concentration of the solute, the fluid properties, or the aquifer properties.
- 5. Ionic and molecular diffusion are negligible contributors to the total dispersive flux.
- 6. Vertical variations in head and concentrations are negligible.

7. The aquifer is homogeneous and isotropic with respect to the coefficients of longitudinal and transverse dispersivity.

Transport Model Input

A model grid of 32 columns by 19 rows with a 250 foot lateral spacing was used. Specified head cells were used at nodes corresponding to the South Branch of the Thunder Bay River, at nodes along the eastern boundary of the model grid area, and also at the sinkhole in the northeastern portion of the model. Groundwater elevations measured during September, 1993 were used as initial input into the transport model. Hydraulic conductivity values were calculated from slug tests performed at Alpena CRTC (Engineering Science, 1989; Earth Technology, 1994). Values of hydraulic conductivity range from 12 feet/day at Site 4 to 278 feet/day at Site 3.

Aquifer thickness values were obtained from drilling records of monitoring wells and soil borings obtained from the SI and RI field activities. Values listed are from logs in which the thickness of the shallow aquifer was clearly discernible, and ranged from 20 feet at Site 5 to 65 feet at Site 8. Transmissivity values were calculated by multiplying the calculated hydraulic conductivity values by the aquifer thickness. Transmissivity ranges from 420 ft²/day at TF4-MW3 to 15,290 ft²/day at CG3-MW5.

Monitoring of the discharge of springs into the sinkhole was performed during the SI (Engineering Science, 1990) and an estimate of approximately 18,000 gallons of water per day discharging into the sinkhole was calculated. In order to obtain a numerical estimate of discharge into the sinkhole for the model, MODFLOW (McDonald and Harbaugh, 1988), a 3- dimensional finite-difference groundwater flow model was used. MODFLOW was used because of its ability to simulate the effect of head-dependent groundwater flow into a groundwater sink (i.e. the sinkhole). This package was not available in MOC. The same model parameters and boundary conditions were used within MODFLOW as in MOC. Based upon hydraulic head data collected in September 1993, discharge from the shallow aquifer into the sinkhole is approximately 30,000 gallons per day.

The dispersivity of an aquifer in two dimensions is described by the longitudinal dispersion, the transverse dispersion and the ratio of the two (Fetter, 1993). As a contaminant plume moves further from its initial location within the aquifer by advection with the groundwater flow, the plume spreads. The spreading in the direction of groundwater flow is the longitudinal dispersion, the spreading in the direction perpendicular to the groundwater flow is known as the transverse dispersion (Fetter, 1993). The values of the dispersion coefficients are typically derived via bench scale tests, aquifer tests, or calibration of contaminant transport models. Since no data presently exists describing dispersivity within the shallow aquifer beneath the Alpena CRTC and insufficient data exists to allow for derivation of dispersivity via model calibration, moderate values of 100 feet for longitudinal dispersivity and 30 feet for transverse dispersivity were chosen (Gillham and Cherry, 1982). A more complete description of the model is given in the report, Preliminary Groundwater Modeling Effort, Earth Technology, August 1993.

Model Calibration:

The groundwater flow model was calibrated with respect to the September 1993 groundwater elevation measurements. Calibration of the groundwater flow model was accomplished by defining a set of parameters, boundary conditions, and stresses that produce simulated heads and fluxes that match field-measured values within a preestablished range of error (Anderson and Woessner, 1992). In order to match field measured values for hydraulic head as determined during September 1993, a few modifications were made to the preexisting groundwater flow model. These changes included updating the initial head array, modeling the sinkhole as a constant head cell to account for the large gradient changes in the vicinity of the sinkhole and including recharge to the model at a rate of 9 inches per year over the whole model area. By adjusting these parameters, an acceptable level of calibration was achieved. An acceptable level of calibration was defined as a root mean squared error (RMS) of less than 2 feet. The RMS, or the standard deviation is the average squared difference in measured and simulated heads and is given by the equation:

RMS=
$$[1/n\sum_{i=1}^{n} (h_m - h_s)_{i}^{2}]^{0.5}$$

n = number of wells $h_m = measured head$ $h_s = model simulated head$

Certain portions of the model may have values above the goal of 2 feet while others fall much below this value. The RMS represents the average error present in the model. The following provides a summary of the final calibrated heads for the flow model.

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
MP2MW1	10,25	679.69	676.68	3.01
MP2MW3	10,22	675.51	675.46	0.05
MP2MW4 5*	11,23	675.34	675.70	-0.36
MP2MW6	11,20	674.86	674.52	0.34
CG3MW1	6,24	677.38	676.69	0.69
CG3MW2	7,22	676.29	675.78	0.51
CG3MW3	9,23	676.50	675.98	0.52
CG3MW4 5*	8,23	676.41	676.08	0.33

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
CG3MW7	8,20	675.64	674.80	0.84
TF4MW1	7,9	667.23	668.83	-1.60
TF4MW2	8,10	659.61	664.22	-4.61
TF4MW3_4*	9,10	658.21	660.06	-1.85
SF5MW1	12,6	674.15	671.34	2.81
SF5MW2	14,5	675.32	672.67	2.65
SF5MW3_4*	13,6	676.46	671.64	4.82
SF5MW6	13,5	674.26	672.40	1.86
LF6MW1	14,9	672.1	670.40	1.70
LF6MW2	14,8	672.68	670.72	1.96
LF6MW3	14,10	671.93	670.21	1.72
LF6MW4	16,7	672.75	671.91	0.84
LF6MW5	15,7	673.07	671.56	1.51
LF6MW6	13,10	671.17	669.67	1.50
LF6MW8	15,9	673.12	670.78	2.34
HN8MW1	5,22	676.96	675.93	1.03
HN8MW2	6,19	675.31	674.50	0.81
HN8MW3_4*	7,21	676.01	675.35	0.66
RT9MW1	6,16	673.06	672.78	0.28
RT9MW2	7,14	668.21	670.81	-2.60
RT9MW3	9,15	670.72	671.26	-0.54
RT9MW4_5*	8,14	667.47	670.32	-2.85
RT9MW6	8,16	670.58	672.33	-1.75
S1MW2	13,26	677.39	676.63	0.76
S1MW3	13,27 -	677.15	676.98	0.17
S1MW11	15,24	675.72	675.67	0.05

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
S1MW12	16,25	674.55	675.94	-1.39
S1MW13	14,24	675.21	675.76	-0.55
S1MW14	14,25	673.92	676.14	-2.22
MP2MW2	12,24	675.57	675.96	-0.39

^{*} Indicates that more than one well is present in each node and an average value for hydraulic head was used.

Sum of Squared Residuals = 128.78/38 = 3.3891 Root Mean Squared Error = 1.84

It should also be noted that the model was calibrated with respect to the September 1993 water level data and should only be considered calibrated with respect to this data. More information on the water level fluctuation through time would be needed to perform a transient calibration. The model was not calibrated with respect to concentration data, but only with respect to hydraulic head.

Model Assumptions and Limitations

- * The model domain consisted only of the shallow unconfined aquifer (i.e. one layer).
- * The initial head data input to the transport model are results of measurements taken in September 1993.
- * Initial concentrations of compounds are results of the Round IV sampling event which was conducted from July to September 1993.
- * Hydraulic conductivity values are the result of slug tests performed in November, 1987 and September 1993.
- * The model was calibrated with respect to hydraulic head using September 1993 water level data and should only be considered calibrated with respect to September 1993 water level data.
- * The flow model was assumed to be at steady-state with respect to hydraulic head.

Site 5

Several chemicals were detected in well SF5MW1 above MDNR Type A or Type B cleanup criteria. These compounds are 1,2- Dichloroethane, 1,4- Dichlorobenzene, Benzene, and Styrene at concentrations of 0.44, 3.5, 52, and 1.5 ug/l, respectively. Chemical data was input to the model and concentrations of the contaminants were monitored along the eastern shore of Lake Winyah and at the sinkhole with respect to time.

Appendix U: Site 6/7 Risk Assessment

Table U-1A

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Groundwater - Site 6/7

MIANG, Alpena CRTC, Alpena, MI

SITE	LOCATOR	SAMPLEID	MATRIX	ANALYTE	RESULT
PC-LF6	MW1	PC-LF6-MW1-GW4	GROUNDWATER	Carbon Tetrachloride	0.1750
PC-LF6	MW10	PC-LF6-MW10-GW4	GROUNDWATER	Carbon Tetrachloride	0.1750
PC-LF6	MW2	PC-LF6-MW2-GW4	GROUNDWATER	Carbon Tetrachloride	0.1750
PC-LF6	MW3	PC-LF6-MW3-GW4	GROUNDWATER	Carbon Tetrachloride	1.1000
PC-LF6	MW4	PC-LF6-MW4-GW4	GROUNDWATER	Carbon Tetrachloride	0.1750
PC-LF6	MW5	PC-LF6-MW5-GW4	GROUNDWATER	Carbon Tetrachloride	0.1750
PC-LF6	MW6	PC-LF6-MW6-GW4	GROUNDWATER	Carbon Tetrachloride	0.1750
PC-LF6	MW8	PC-LF6-MW8-GW4	GROUNDWATER	Carbon Tetrachloride	0.1750
PC-LF6	MW9	PC-LF6-MW9-GW4	GROUNDWATER	Carbon Tetrachloride	0.1750

Table U-2A
Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Sediment - Site 6/7
MIANG, Alpena CRTC, Alpena, MI

ΑT	LOCATOR	SAMPLEID	MATRIX	ANALYTE	SAMPLE DEPTH	TH	RESULT
					RANGE		
PC-LF6-SD1	PC-LF6-SD1		SEDIMENT	Anthracene	00000	00000	550,0000
PC-LF6-SD2	PC-LF6-SD2		SEDIMENT	Anthracene	00000	0000	1150,0000
PC-LF6-SD3	PC-LF6-SD3		SEDIMENT	Anthracene	0,0000	0.0000	348,0000
PC-LF6-SD1	PC-LF6-SD1		SEDIMENT	Benzo(a)anthracene	0.0000	0.0000	550,0000
PC-LF6-SD2	PC-LF6-SD2		SEDIMENT	Benzo(a)anthracene	0.0000	00000	1150,000
PC-LF6-SD3	PC-LF6-SD3		SEDIMENT	Benzo(a)anthracene	0.0000	00000	343 0000
PC-LF6-SD1	PC-LF6-SD1		SEDIMENT	Benzo(a)pyrene	0.0000	00000	2500000
PC-LF6-SD2	PC-LF6-SD2		SEDIMENT	Benzo(a)pyrene	0.0000	00000	1150,0000
PC-LF6-SD3	PC-LF6-SD3		SEDIMENT	Benzo(a)pyrene	0.000	00000	278,0000
PC-LF6-SD1	PC-LF6-SD1		SEDIMENT	Benzo(b)fluoranthene	00000	00000	250,000
PC-LF6-SD2	PC-LF6-SD2		SEDIMENT	Benzo(b)fluoranthene	0.0000	0.0000	1150.0000
PC-LF6-SD3	oc-LF6-SD3		SEDIMENT	Benzo(b)fluoranthene	00000	0.0000	462.0000
PC-LF6-SD1	oc-LF6-SD1		SEDIMENT	Benzo(ghi)perylene	00000	0.0000	550,0000
PC-LF6-SD2	C-LF6-SD2		SEDIMENT	Benzo(ghi)perylene	0.000	0.0000	1150,0000
PC-LF6-SD3	PC-LF6-SD3		SEDIMENT	Benzo(ghi)perylene	0.0000	0.0000	148.0000
PC-LF6-SD1	oc-LF6-SD1		SEDIMENT	Benzo(k)fluoranthene	00000	0.0000	550,0000
PC-LF6-SD2	oc-LF6-SD2		SEDIMENT	Benzo(k)fluoranthene	0,000	0.0000	1150.0000
PC-LF6-SD3	C-LF6-SD3		SEDIMENT	Benzo(k)fluoranthene	00000	0.0000	462.0000
PC-LF6-SD1	C-LF6-SD1		SEDIMENT	Butyl benzyl phthalate	00000	00000	550,0000
PC-LF6-SD2	PC-LF6-SD2		SEDIMENT	Butyl benzyl phthalate	0.0000	0.0000	510.0000
PC-LF6-SD3	C-LF6-SD3		SEDIMENT	Butyl benzyl phthalate	0.0000	0.0000	90,000
PC-LF6-SD1	C-LF6-SD1		SEDIMENT	Carbazole	0.0000	00000	550,0000
PC-LF6-SD2	C-LF6-SD2		SEDIMENT	Carbazole	00000	00000	1150.0000
PC-LF6-SD3	C-LF6-SD3		SEDIMENT	Carbazole	00000	0.0000	162.0000
PC-LF6-SD1	C-LF6-SD1		SEDIMENT	Chromium	00000	00000	4.9000
PC-LF6-SD2	C-LF6-SD2		SEDIMENT	Chromium	0.0000	0.0000	15,9000
PC-LF6-SD3	C-LF6-SD3		SEDIMENT	Chromium	00000	0.000	6.3000
PC-LF6-SD1	C-LF6-SD1		SEDIMENT	Chrysene	00000	00000	550,0000
PC-LF6-SD2	C-LF6-SD2		SEDIMENT	Chrysene	00000	0.000	1150.0000
PC-LF6-SD3	C-LF6-SD3		SEDIMENT	Chrysene	00000	0.000	332,0000
PC-LF6-SD1	C-LF6-SD1		SEDIMENT	Copper	00000	00000	6.2000
PC-LF6-SD2	C-LF6-SD2		SEDIMENT	Copper	00000	00000	16.4000

Table U-2A (continued)

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Sediment - Site 6/7

MIANG, Alpena CRTC, Alpena, MI

SITE	LOCATOR	SAMPLEID	MATRIX	ANALYTE	SAMPLE DEPTH RANGE	HTC	RESULT
PC-LF6	SD3	PC-LF6-SD3	SEDIMENT	Copper	0.0000	0.0000	12.8000
PC-LF6	SD1	PC-LF6-SD1	SEDIMENT	Di-n-butyl phthalate	00000	0.0000	550,0000
PC-LF6	SD2	PC-LF6-SD2	SEDIMENT	Di-n-butyl phthalate	0.0000	0.0000	1150.0000
PC-LF6	SD3	PC-LF6-SD3	SEDIMENT	Di-n-butyl phthalate	00000	0.0000	150.0000
PC-LF6	SD1	PC-LF6-SD1	SEDIMENT	Fluoranthene	0.0000	0.0000	250,0000
PC-LF6	SD2	PC-LF6-SD2	SEDIMENT	Fluoranthene	0.0000	0.000	540.0000
PC-LF6	SD3	PC-LF6-SD3	SEDIMENT	Fluoranthene	0.0000	0.0000	442.0000
PC-LF6	SD1	PC-LF6-SD1	SEDIMENT	Indeno(1,2,3-c,d)pyrene	0.0000	0.0000	550,0000
PC-LF6	SD2	PC-LF6-SD2	SEDIMENT	Indeno(1,2,3-c,d)pyrene	0.0000	0.000	1150.0000
PC-LF6	SD3	PC-LF6-SD3	SEDIMENT	Indeno(1,2,3-c,d)pyrene	0.0000	0.000	178.0000
PC-LF6	SD1	PC-LF6-SD1	SEDIMENT	Lead	0.0000	00000	5.3000
PC-LF6	SD2	PC-LF6-SD2	SEDIMENT	Lead	00000	0.0000	177.0000
PC-LF6	SD3	PC-LF6-SD3	SEDIMENT	Lead	0.0000	0.0000	40.8000
PC-LF6	SD1	PC-LF6-SD1	SEDIMENT	Nickel	0.0000	0.0000	5.5500
PC-LF6	SD2	PC-LF6-SD2	SEDIMENT	Nickel	0.0000	0.0000	12.7500
PC-LF6	SD3	PC-LF6-SD3	SEDIMENT	Nickel	00000	0.0000	5.2800
PC-LF6	SD1	PC-LF6-SD1	SEDIMENT	Phenanthrene	00000	0.0000	250.0000
PC-LF6	SD2	PC-LF6-SD2	SEDIMENT	Phenanthrene	0.0000	0,0000	310.0000
PC-LF6	SD3	PC-LF6-SD3	SEDIMENT	Phenanthrene	00000	0.0000	348.0000
PC-LF6	SD1	PC-LF6-SD1	SEDIMENT	Pyrene	0.0000	0.0000	550,0000
PC-LF6	SD2	PC-LF6-SD2	SEDIMENT	Pyrene	00000	0.000	290:0000
PC-LF6	SD3	PC-LF6-SD3	SEDIMENT	Pyrene	0.0000	00000	328.0000
PC-LF6	SD1	PC-LF6-SD1	SEDIMENT	Selenium	0.0000	0.0000	0.4750
PC-LF6	SD2	PC-LF6-SD2	SEDIMENT	Selenium	0.0000	0.0000	2.3000
PC-LF6	SD3	PC-LF6-SD3	SEDIMENT	Selenium	0,0000	0.0000	0.2150

TABLE U-1 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH SEDIMENT SIDE OF 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

Parameter	ADULT	CHILD
Sidn Surface Area Available for Contact (cm^2/day)	3120	007+
Soll to Skin Adherence Factor (mo/cm/2)	0710	0641
Absorption Factor, Unittess	77.7	2.11
Metals	100	0
	10.0	10.01
Jugarnes	0.25	0.25
Exposure Factor (days/year)	48	200
Exposure Duration (year)	25	. T
Sody Weight (Mograms)	92	0 0
Conversion Earlor		17
	1E-06	1E-06
Averaging Time (years)		
Carcinogens	7.0	7.0
Noncarcinogens	36	2 4

TABLE U-2 DAILY INTAKE - ADULT
DERMAL CONTACT WITH SEDIMENT
FUTURE LAND USE SCENARIO

Noncarchogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, Mi

	Chemical	Conversion	Available	Soft to	Absorption	Exposure	Exposure	Body	Average	Absorbed
Chemical	Concentration	Factor	Sidn Surface	Skin Adherence	Factor	Frequency	Duration	Weight	Time	Dose
	(mg/kg)	(kg/mg)	(cm^2/day)	(mg/cm ²)	(uniffess)	(days/year)	(years)	(kg)	(days)	(mg/kg-day)
Anthracene	1,150E+00	1.00E-06	3120	2.77	0.25	48	25	70	9125	4.668E-06
Benzo(a)anthracene	1,150E+00	1.00E-06	3120	2.77	0.25	48	25	70	9125	4.868E-08
Benzo(a)pyrene	1,150E+00	1.00E-06	3120	2.77	0.25	48	25	70	9125	4.668E-08
Benzo(b)fluoranthene	1,150E+00	1.00E-06	3120	2.77	0.25	4 8	25	70	9125	4.668E-06
Benzo(ght)perviene	1,150E+00	1.00E-06	3120	2.77	0.25	84	25	70	9125	4.868E-08
Benzo(k)fluoranthene	1.150E+00	1.00E-06	3120	2.77	0.25	48	25	70	9125	4.868E-08
Buty benzy phthalate	5.500E-01	1.00E-06	3120	2.77	0.25	48	25	70	9125	2.232E-08
Carbazole	1.150E+00	1.00E-06	3120	2.77	0.25	48	25	70	9125	4.868E-08
Chrysene	1.150E+00	1.00E-06	3120	2.77	0.25	48	25	70	9125	4.668E-06
Di-n-butyl phthalate	1.150E+00	1.00E-06	3120	2.77	0.25	4 8	25	70	9125	4.668E-08
Fluoranthene	5.500E-01	1.00E-06	3120	2.77	0.25	48	25	70	9125	2.232E-08
Indeno(1,2,3-c,d)pyrene	1,150E+00	1.00E-06	3120	2.77	0.25	48	25	70	9125	4.668E-08
Lead	1.770E+02	1.00E-06	3120	2.77	0.01	8*	25	70	9125	2.874E-05
Phenanthrene	5.500E-01	1.00E-06	3120	2.77	0.25	84	25	70	9125	2.232E-08
Pyrene	5.500E-01	1.00E-06	3120	2.77	0.25	48	25	70	9125	2.232E-08
Selenium	2.300E+00	1.00E-06	3120	2.77	0.01	48	25	70	9125	3.734E-07

TABLE U-\$ DAILY INTAKE - CHILD DERMAL CONTACT WITH SEDIMENT FUTURE LAND USE SCEMARIO Noncarcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, M

Concentration Factor Skin Surface Factor Factor Concentration Factor Skin Surface Factor Factor Concentration Factor Skin Surface Factor Factor Factor Concentration (4g/mg)		Chemical	Conversion	Available	Soll to	Absorption	Exposure	Exposure	Body	Average	Absorbed
(mg/kg) (rmg/kg) (rm/2/day) (mg/cm/2)	Chemical	Concentration	Factor	Skin Surface	Skin Adherence	Factor	Frequency	Duration	Weight	Tlme	Dose
1.50E+00		(mg/kg)	(kg/mg)	(cm ^A 2/day)	(mg/cm ⁴ 2)	(nultiess)	(days/year)	(years)	(kg)	(days)	(mg/kg-day)
1.150E+00 1.00E-06 1490 2.77 2.30E-01 1.00E-06 1490 2.77	Anthracene	1.150E+00	1.00E-06	1490	2.17	0.25	48	15	27	5475	5.779E-06
1.150E+00 1.00E-06 1490 2.77 2.30E-01 1.00E-06 1490 2.77	Benzo(a)anthracene	1,150E+00	1.00E-06	1490	2.77	0.25	48	15	27	5475	5.779E-08
1.150E+00 1.00E-06 1490 2.77 2.300E-01 1.00E-06 1490 2.77 2.300E-01 1.00E-06 1490 2.77 2.300E+00 1.00E-06 1490 2.77 2.300E+00 1.00E-06 1490 2.77 2.300E+00 1.00E-06 1490 2.77	Benzo(a)pvrene	1.150E+00	1.00E-06	1490	2.77	0.25	48	15	27	5475	5.779E-08
1.150E+00 1.00E-06 1480 2.77 1.150E+00 1.00E-06 1480 2.77 1.150E+00 1.00E-06 1490 2.77 2.30E-01 1.00E-06 1490 2.77	Benzo(b)fluoranthene	1.150E+00	1.00E-06	1490	2.77	0.25	84	15	27	5475	5.779E-08
1,150E+00 1,00E-06 1480 2,77 (2.77 (Benzo(ah)berMene	1.150E+00	1.00E-06	1490	2.77	0.25	84	15	27	5475	5.779E-08
5,500E-01 1,00E-06 1490 2.77 1,150E+00 1,00E-06 1490 2.77 5,500E-01 1,00E-06 1490 2.77 2,300E+01 1,00E-06 1490 2.77 2,300E+01 1,00E-06 1490 2.77 2,300E+01 1,00E-06 1490 2.77	Benzo(k)fluoranthene	1,150E+00	1.00E-06	1490	2.77	0.25	84	15	27	5475	5.779E-08
1.150E+00 1.00E-06 1490 2.77 1.770E+02 1.00E-06 1490 2.77 5.500E-01 1.00E-06 1490 2.77 2.300E+01 1.00E-06 1490 2.77 2.300E+01 1.00E-06 1490 2.77 2.300E+01 1.00E-06 1490 2.77	But benzy phthalate	5.500E-01	1.00E-06	1490	2.77	0.25	84	15	27	5475	2.784E-08
1.150E+00 1.00E-06 1490 2.77 1.150E+00 1.00E-06 1490 2.77 5.500E-01 1.00E-06 1490 2.77 1.150E+02 1.00E-06 1490 2.77 1.770E+02 1.00E-06 1490 2.77 5.500E-01 1.00E-06 1490 2.77 2.300E-01 1.00E-06 1490 2.77 2.300E-01 1.00E-06 1490 2.77 2.300E-01 1.00E-06 1490 2.77	Carbazole	1.150E+00	1.00E-06	1490	2.77	0.25	87	15	27	5475	5.779E-08
1.150E+00 1.00E-06 1490 2.77 5.500E-01 1.00E-06 1490 2.77 1.770E+00 1.00E-06 1490 2.77 5.500E-01 1.00E-06 1490 2.77 5.500E-01 1.00E-06 1490 2.77 2.300E+00 1.00E-06 1490 2.77 2.300E+00 1.00E-06 1490 2.77 2.300E+00 1.00E-06 1490 2.77	Chrysene	1.150E+00	1.00E-06	1490	2.77	0.25	84	15	27	5475	5.779E-08
5.500E-01 1.00E-06 1490 2.77 1.150E-00 1.00E-06 1490 2.77 1.770E-02 1.00E-06 1490 2.77 5.500E-01 1.00E-06 1490 2.77 2.300E-01 1.00E-06 1490 2.77 2.300E-01 1.00E-06 1490 2.77 2.300E-01 1.00E-06 1490 2.77	Di-n-buty phthalate	1.150E+00	1.00E-06	1490	2.77	0.25	48	15	27	5475	5.779E-08
2,3-c,d)pyrene 1,150E+00 1,00E-06 1490 2.77 1,770E+02 1,00E-06 1490 2.77 rene 5,500E-01 1,00E-06 1490 2.77 2,500E-01 1,00E-06 1490 2.77 2,500E-01 1,00E-06 1490 2.77	Fluoranthene	5.500E-01	1.00E-06	1490	2.77	0.25	84	15	27	5475	2.784E-08
1.770E+02 1.00E-06 1490 2.77 1.650E-01 1.00E-06 1490 2.77 2.300E-01 1.00E-06 1490 2.77 2.300E+01 1.00E-06 1490 2.77	Indeno(1.2.3-c.d)pvrene	1.150E+00	1.00E-06	1490	2.77	0.25	48	15	27	5475	5.779E-06
rene 5,500E-01 1,00E-06 1490 2.77 5,500E-01 1,00E-06 1490 2,77 2,200E-01 1,00E-06 1490 2,77 2,770 2,770 2,77	lead	1.770E+02	1.00E-06	1490	2.77	0.01	84	15	27	5475	3,558E-05
5.500E-01 1,00E-06 1490 2.77 2.300E+00 1,00E-06 1490 2.77	Phenanthrene	5.500E-01	1.00E-06	1490	2.77	0.25	84	15	27	5475	2.784E-08
2.300E+00 1.00E-06 1490 2.77	Pyrene	5.500E-01	1.00E-06	1490	2.77	0.25	84	15	27	5475	2.764E-08
	Selenium	2.300E+00	1,00E-06	1490	2.77	0.01	48	15	27	5475	4.624E-07

U-4 DAILY INTAKE - ADULT DERMAL CONTACT WITH SEDIMENT FUTURE LAND USE SCENARIO TABLE

Exposure Frequency (days/year) Soll to Skin Adherence Carcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Traibing Area, Alpena CRTC, Alpena, MI Factor Factor (Factor) (Ag/mg) (Ag/mg) (10E-06 1.0E-06 Chemical Concentration (mg/N) Chrysene
Di-n-buty phthalate
Fluoranthene
Indeno(1,2,3-c,d)pyrene Arthracene
Benzo(a)anthracene
Benzo(a)pyene
Benzo(b)fuoranthene
Benzo(tyfluoranthene
Benzo(tyfluoranthene
Buydy benzy phtmalate
Carbazole Phenanthrene Pyrene Selenium Chemical

Dose (mg/lq-da/) 1667E-06 1567E-06 1567

Average (1849) 25550 255

U-6 DAILY INTAKE - CHILD DERMAL CONTACT WITH SEDIMENT FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, Mi

	Chemical	Conversion	Avallable	Solf to	Absorption	Exposure	Exposure	Body	Average	Ahsorhad
Chemical	Concentration	Factor	Skin Surface	Skin Adherence	Factor	Frequency	Duration	Welght	Tme	Doce
	(mg/kg)	(kg/mg)	(cm^2/day)	(mg/cm*2)	(unitiess)	(davs/vear)	(vears)	(ku)	(dave)	(veb ra/ran/
Anthracene	1.150E+00	1.0E-06	1490	2.77	0.25	48	15	27	25550	1 228 08
Benzo(a)anthracene	1.150E+00	1.0E-06	1490	2.77	0.25	4	. .	27	25550	1 2385 08
Benzo(a)pyrene	1.150E+00	1.0E-06	1490	2.77	0.25	48	5	72	25550	1 238 E DE
Benzo(b)fluoranthene	1.150E+00	1.0E-06	1490	2.77	0.25	€	5	27	25550	1 238E DB
Benzo(ghl)perylene	1.150E+00	1.0E-06	1490	2.77	0.25	₩.	15	27	25550	1 238F.08
Benzo(k)fluoranthene	1,150E+00	1.0E-06	1490	2.77	0.25	. 4	5	7.0	25550	1 238 E DB
Butyl benzyl phthalate	5.500E-01	1.0E-06	1490	2.77	0.25	48	5	22	25550	5 023E 07
Carbazole	1.150E+00	1.0E-06	1490	2.77	0.25	- 48	. .	, 7	25550	1.238E-06
Chrysene	t.150E+00	1.0E-06	1490	2.77	0.25	48	. 2 0	22	25550	1238F-06
DI-n-butyl phthalate	1.150E+00	1.0E-06	1490	2.77	0.25	48	£	27	25550	1238F-06
Fluoranthene	5.500E-01	1.0E-06	1490	2.77	0.25	48	5	27	25550	5.923F-07
Indeno(1,2,3-c,d)pyrene	1,150E+00	1.0E-06	1480	2.77	0.25	48	15	27	25550	1,238E-06
Cead	1.770E+02	1.05-06	1490	2.77	0.01	48	15	27	25550	7.625E-06
Frenanurene	5.500E-01	1.0E-06	1490	2.77	0.25	48	15	27	25550	5.923E-07
Fyrene	5.500E-01	1.0E-06	1490	2.77	0.25	48	15	27	25550	5.923E-07
Selenium	2.300E+00	1.0E-06	1490	2.77	0.01	48	15	27	25550	9.908E-08

TABLE U-6 EXPOSURE ASSESSMENT PARAMETERS - SEDIMENT INGESTION Street And Treat Firet Fire Training Area, Alpena CRTC, Alpena, MI

	RECREATIONAL RECREATIONAL	RECREATIONAL
PARAMETER	ADUI, I	CHILD
Ingestion Rate (mg/day)	100	200
Fraction Ingested from		
Contaminated Sources (unitless)	-	1
Exposure Frequency (days/year)	48	48
Exposure Duration (years)	25	9
Body Weight (kilograms)	02	15
Conversion Factor	1E-06	1E-06
Averaging Times (years)		
Carcinogens	70	70
Noncarcinogens	25	9

U-7 DAILY INTAKE - ADULT SEDIMENT INGESTION FUTURE LAND USE SCENARIO - RECREATIONAL ADULT TABLE

Noncarcinogenic Effect Exposure Assessment Site 6 & 7, Former Sold Waste Landfill and First Fire Training Area, Algena CRTC, Algena, MI

	Chemical	Conversion		Fraction	Exposition	Fxnosura	Body	Average	
Chamical	Concentration	Rate	Ingestion Rate	Ingested	Frequency	Duration	Woirht	Time	otolo Ostol
	(mg/kg)		(wd/day)	(unitless)	(days/year)	(voare)	(140)	(dose)	BIBLI CABALLI
Anthracene	1.150f + 00	1E-06	100		48	25	202	0426	(mg/kg-day)
Benzo(a) anthracene	1.150€ +00	1E-06	100		0.0	200	2 6	9123	Z.TBUE-U/
Велго(в) ругеле	1.150E + 00	15-06	100		000	62	0 6	9125	2.160E-07
Benzo(b)fluoranthene	1 1505 ± 00	4 1 1 2 2	000	- 4	0.7	67	2	9125	2.160E-07
Renzelehilnervlene	1 1505 - 00	11-00	001		48	25	70	9125	2.160E-07
Description and the property of the property o	1.130E + 00	1E-00	001	-	48	25	70	9125	2.160E-07
Senzo(k) iluoranthene	1.150E + 00	1E-06	100	-	48	25	70	9125	2 1605 07
Butyl benzyl phthalate	5.500E-01	1E-06	100	-	48	25	20	0426	4 000F-07
Carbazole	1,150E + 00	1E-06	100	. 4-	48	24 0	1 9	9120	1.0335-07
Chrysene	1 1506 + 00	40.00	100		0 (07	0	9125	2.160E-07
Die butyd abthalists	4 47.07 - 00	15.00	001	_	48	52	70	9125	2.160E-07
Floor and Programment	1.150E + 00	1E-06	100	-	48	22	70	9125	2 160F-07
ridoranthene	5.500E-01	1E-06	100	-	48	25	70	9125	4 0225 07
Indena(1,2,3.c,d)pyrene	1,150F + 00	1E-06	100	+	40	9 0	0 6	0.400	10-3500
Lead	1 7 7 OE + 0.9	30 14	100		G# :	67	0/	6716	2.160E-07
Discontinuo	10 TOO 1 TO	20-11	001	_	48	52	70	9125	3,325E-05
2 1141144111111111111111111111111111111	5.500E-01	30-11-06	100	_	48	25	70	9125	4 032E 07
Ругапе	5.500F-01	1E-06	100	-	433	35	2 6	0120	1000 TOOO T
Salenium	2 3006 1.00	15 NB	100		9	24	2	6716	1.033E-07
	COOKET ON	8-31	8	~	48	25	70	9125	4.321E-07

U-8 DAILY INTAKE · CHILD SEDIMENT INGESTION FUTURE LAND USE SCENARIO · RECREATIONAL CHILD TABLE

Noncarcinogonic Effect Exposure Assasment Site 6 & 7, Former Sold Waste Landill and First Fire Training Area, Alpena CRTC, Alpena, M.

	Chemical	Conversion	Adult	Fraction	Guisoux	Cynnelling	Dody	Assessment	
Chemical	Concontration	Rafe	Ingrestion Bato	potagonal		CAMOSING	Apoo .	AVERAGE	
	2			marchin	Lindamick	LAURATION	Weight	IIMe	Intake Rate
A A -	(B) Burl		(Aub/bu)	(muthoss)	(days/your)	(yours)	(ka)	(davs)	(veb-da/out)
Anthracene	1.150F ± 00	1E-06	200	-	48	9	15	2190	20165 06
Benzo(a) anthracena	1,150E + 00	1E-06	200		48	. (4	, t	2400	2.0 ISE-00
Вапго(в)ругала	1.150E ± 00	1E-06	200	•	7	0 0	2 ;	2130	2.0 lbE-06
Quiva (hither pothogo	00 - 101-	2007	200	-	48	9	15	2190	2.016E-06
Design (p) and all thinks	1.130E + 00	1E-06	200	-	48	9	15	2190	2.016F-06
Renzo(ghi)perylene	1.150E + 00	1E-06	200	-	48	4	1,5	2190	2019000
Benzo(k)fluoranthene	1,150E + 00	1E-06	200	•	9	0 4	2 4	2,000	2.016E-00
Rutyl honzyl obtholoto	5 5000	000 11	000	- 4	0	٥	C.	2190	2.016E-06
Control of the contro	10.3000.0	1E-00	7007		48	ဖ	15	2190	9.644F-07
Carbazoio	1.1500 + 00	1E-06	200	-	48	9	4	2190	2018E 06
Chrysenn	1.150F ±00	15-06	200				2 4	0010	2.0105-00
Dies burtal abithalata	00 1014	0 0	007		40	٥	0	2190	2.016E-06
Signature production	1, 190E + 00	30-3L	200	_	48	9	15	2190	2.016F-06
l-luoranthene	5.500E-01	1E-06	200	-	48	9	15	2190	06445.07
Indeno(1,2,3-c,d)pyrana	1,150E + 00	1E-06	200	4-	48		4	100	0.040.0
Learl	1 7701: 02	100	000		OF !	0	2	7130	Z.016E-06
44	7,100.4 02	30-5	200	_	48	9	15	2190	3.104E-04
- Hondantin Brid	5.500E-01	1E-06	200	-	48	9	15	2190	9 644F-07
Pyrene	5.500E-01	1E-06	200	*	48	9	15	2190	9 644E-07
Selenium	2.300E + 00	1E-06	200	-	48	9	15	2190	4 033E-06
									3

U-9 DAILY INTAKE - ADULT SEDIMENT INGESTION FUTURE LAND USE SCENARIO - RECREATIONAL ADULT TABLE

Carcinogonic Effect Exposure Assessment Site 6.8.7; Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

	Chemical	Conversion	Adult	Fraction	Exposure	Exposure	Body	Average	
Chemical	Concentration	Rate	Ingestion Rate	Ingested	Frequency	Duration	Weight	Time	Intake Rate
	(mg/kg)		(mg/day)	(unitless)	(days/year)	(yours)	(kg)	(skep)	(mg/kg-day)
Anthracene	1.150E + 00	1E-06	100	1	48	25	70	25550	7.716E-08
Benzo(a) anthracene	1.150E + 00	1E-06	100	-	48	25	70	25550	7.716E-08
Benzo(a)pyrene	1.150E + 00	1E-06	100	-	48	25	70	25550	7.716E-08
Benzo(b)fluoranthene	1.150E + 00	1E-06	100	-	48	25	70	25550	7.716E-08
Benzo(ghi) perylene	1.150E + 00	1E-06	100	-	48	25	70	25550	7.716E-08
Benzo(k)fluoranthene	1,150£ ±00	1E-06	100	F	48	25	70	25550	7.716E-08
Butyl benzyl phthalate	5,500E-01	1E-06	100	F	48	25	70	25550	3.690E-08
Carbazole	1.150E + 00	1E-06	100	-	48	25	70	25550	7.716E-08
Chrysene	1.150E + 00	1E-06	100	F	48	25	70	25550	7.716E-08
Di-n-butyl phthalate	1.150E + 00	1E-06	100	-	48	25	70	25550	7.716E-08
Fluoranthene	5.500E-01	1E-06	100	+	48	25	70	25550	3.690E-08
Indeno(1,2,3.c,d)pyrene	1,150E + 00	1E-06	100	-	48	25	70	25550	7.716E-08
Lead	1.770E + 02	1E-06	100	-	448	25	20	25550	1.188E-05
Phonanthrene	5,500E-01	15-06	100	-	48	25	70	25550	3.690E-08
Pyrana	5.500E-01	1E-06	100	-	48	25	70	25550	3.690E-08
Solenium	2.300E + 03	1E-06	100	-	48	25	70	25550	1.543E-07
Fluoranthene	5.500E-01	1E-06	100	-	48	25	20	25550	3.690E-08
Indeno(1,2,3-c,d)pyrene	1.150E + 00	1E-06	100	-	48	25	70	25550	7.716E-08
Lead	1.770E + 02	1E-06	100	+	48	25	70	25550	1.188E-05
Phenanthrene	5,5006:01	1E-06	100	***	48	25	70	25550	3.690E-08
Pyrene	5.500E-01	1E-06	100	1	48	25	70	25550	3.690E-08
Selenium	2.300E + 00	1E-06	100	۳-	48	25	70	25550	1.543E-07

TABLE

U-10 DAILY MTAKE - CHILD SEDIMENT INGESTION FUTURE LAND USE SCENARIO - RECREATIONAL CHILD

Cercinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpera CRTC, Alpera, MI

Imake Rate Img/kg-day/ Img/kg-day/ 1728E-07 1728E-08 126E-08 126E (days)
25550
25550
25550
25550
25550
25550
25550
25550
25550
25550
25550
25550
25550
25550
25550
25550
25550
25550
25550 Ingestion Rate Conversion Rate Chamical Concentration (mg/kg)
1.150E+00
1.150 Anthracane
Benzocia anthracene
Benzocia privane
Benzocia privane
Benzocibiluoranthene
Benzocibiluoranthene
Bury benzy phthalato
Carbazole
Chrysean
Di n bury phthalato
I kuy cantund
Li 2,3-c,dipyrene
Lad Pyrene Selenium Phenanthrene Pyrene Chemical

TABLE U-11 EXPOSURE ASSESSMENT PARAMETERS - FISH INGESTION Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	C
Fraction of Fish Ingested, unitless	0.5	3.0
Ingestion rate kg/day	0.054	0.043
Exposure Frequency days/yr	26	92
Exposure Duration (years)	25	15
Body Weight, Kg	70	27.
Averaging Time		ì
Carcinogens	70	02
Noncarcinogens	25	5 5

U-12 DAILY INTAKE - ADULT FISH INGESTION FUTURE LAND USE SCENARIO TABLE

Noncarcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

Chemical	Chemical * Concentration	Ingestion Rate	Exposure Frequency	Fraction Ingested	Exposure Duration	Body Weight	Averaging Time	Intake
	(mg/kg)	(kg/day)	(days/year)	(unitless)	(years)	(kg)	(days)	
Carbon Tetrachloride	1.700E-04	0.054	56	0.5	25	70	9125	

^{*} Concentration adjusted from surface water concentration to fish concentration by bioconcentration factor of 17

U-13 DAILY INTAKE - CHILD FISH INGESTION FUTURE LAND USE SCENARIO TABLE

Noncarcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

	Chemical *	Ingestion	Exposure	Fraction	Expositre	Body	Average	
Chemical	Concentration	Rate	Frequency	Ingested	Duration	Weight	Time	Rate
	(mg/kg)	(kg/day)	(days/year)	(unitless)	(years)	(kg)	(days)	
Carbon Tetrachloride	1.700E-04	0.043	56	0.5	15	27	5475	

^{*} Concentration adjusted from surface water concentration to fish concentration by bioconcentration factor of 17

U-14 DAILY INTAKE - ADULT FISH INGESTION FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

	25550	70	25	0.5	56	0.054	1.7005-04	Carbon retrachionde
(mg/Kg-day)	(days)	(kg)	(years)	(unitless)	(days/year)	(kg/day)	(mg/kg)	Carleson Total all
		160		,			1101	
	Time	Weight	Duration	Ingested	Frequency	Rate	Concentration	Chellical
	Averaging	Apog	Exposure	LIACTION	CAPUSUIE	Topico Sim		7
			Ĺ			Ingention	Chemical *	

^{*} Concentration adjusted from surface water concentration to fish concentration by bioconcentration factor of 17

U-15 DAILY INTAKE - CHILD FISH INGESTION FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

	Chemical	Ingestion	Exposure	Fraction	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Ingested	Duration	Weight	Time	Rate
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	(mg/kg)	(kg/day)	(days/year)	(unitless)	(years)	(kg)	(days)	(mg/Kg-day)
Carbon retrachioride	1. / UUE-U4	0.043	56	0.5	15	27	25550	2.066E-09

^{*} Concentration adjusted from surface water concentration to fish concentration by bioconcentration factor of 17

TABLE U-16 EXPOSURE ASSESSMENT PARAMETERS - INGESTION OF SURFACE WATER Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	CHILD
Exposure Time (hrs/day)	2.6	2.6
Surface Water Contact Rate (ml/hr)	50	50
Exposure Frequency (days/year)	48	48
Exposure Duration (years)	25	15
Body Weight, Kg	70	27
Averaging Time		
Carcinogens	70	70
Noncarcinogens	25	15

TABLE U-17 DAILY INTAKE - ADULT SURFACE WATER INGESTION FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

	Chemical	Contact	Exposure	Exposure	Exposure	Body	Averaging	
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(mg/kg)	(L/day)	(days/year)	(hrs/day)	(vears)	(ka)	(days)	/wa/K
Carbon Tetrachloride	1.000E-05	0.050	48	2.6	25	02	9125	2.442E-09

TABLE U-18 DAILY INTAKE - CHILD SURFACE WATER INGESTION FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Arca, Alpena CRTC. Alpena. M

Order of the control	Albenia and this trie training Area, Albenia CKIC, Albenia	CKIC, Albena	MI					
Chemical	Chemical Concentration	Contact Rate	Exposure Frequency	Exposure Time	Exposure Duration	Body Weight	Averaging Time	Intake Rate
	(mg/kg)	(L/day)	(days/year)	(hrs/dav)	(vears)	(ka)	(dave)	(ma/Ka-day)
Carbon Tetrachloride	1.000E-05	0.050	48	2.6	15	27	5475	6.332E-09

TABLE U-19 DAILY INTAKE - ADULT SURFACE WATER INGESTION FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

	Chemical	Contact	Exposure	Exposure	Exposure	Body	Averaging	
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(mg/kg)	(L/day)	(days/year)	(hrs/day)	(years)	(kg)	(days)	
Carbon Tetrachloride	1.000E-05	0.050	48	2.6	25	02	25550	

TABLE U.20 DAILY INTAKE - CHILD SURFACE WATER INGESTION FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, Mi

	Chemical	Contact	Exposure	Exposure	Exposure	Body	Averaging	intake
Chemical	Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
	(mg/kg)	(L/day)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(mg/Kg-day)
Carbon Tetrachloride	1.000E-05	0.050	48	2.6	15	27	25550	1.357E-09

TABLE U-21 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH THUNDERBAY RIVER SURFACE WATER Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, M

PARAMETER	ADIIIT	2
Skin Surface Area Available for Contact (so cm)	10400	19300
Evanger Time the Adams	0000	13300
(APD/SIL) ALLIANDOCKT	2.6	2.6
Dermal Permeability Constant	0.00084	0.00084
Exposure Frequency (days/year)	48	48
Exposure Duration (years)	3.0	Į.
	6.7	2
Body Weight, Kg	70	27
Averaging Time		i
Carcinogens	70	20
Noncarcinodens	30) L
1	CN.	0
Conversion Factor	600	0
	00.0	0.001

TABLE U-22 DAILY INTAKE - ADULT SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI.

		Chemical	Dermal	Skin		Exposure	Exposure	Body	Averaging	-	
Chemical		Concentration	Permeability	Surface Area	Frequency	Time	Duration	Weight	Time	Factor	Rate
		(mg/l)	(cm/hr)	(sd cm)	<u></u>	(hrs/day)	(years)	(kg)	(days)		
Carbon Tetrachloride	(q)	1.000E-05	0.022	19400	48	2.6	25	20	9125		

(b) Predicted PC (Table 5-7 of U.S. EPA, 1992a).

TABLE U-23 DAILY INTAKE - CHILD SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO Noncarcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

		Chemical	Dermal	Skin	Exposure	Exposure	Exposure	Body	Averaging		Intake
Chemical		Concentration	Permeability	Surface Area	Frequency	Time	Duration	Weight	Time	Factor	Rate
		(mg/l)	(cm/hr)	(sd cm)	(days/year)	(hrs/day)	(years)	(kg)	(days)		(mg/Kg-day)
Carbon Tetrachloride	(p)	1.000E-05	0.022	13300	48	2.6	15	27	5475		3.705E-08

(b) Predicted PC (Table 5-7 of U.S. EPA, 1992a).

SITE6A.WB1/940127

U-24 DAILY INTAKE - ADULT SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

Chemical		Concentration	Dermal Permeability	Skin Surface Area	Exposure Frequency	Exposure Time	Exposure	Body Weight	Averaging Time	Conversion	Intake
		(mg/l)	(cm/hr)	(sd cm)	(days/year)	(hrs/day)	(years)	(kg)	(davs)	(I/cn cm)	(ma/K
Carbon Tetrachloride	(Q)	1.000E-05	0.022	19400	48	2.6	25	70	25550	0.001	7.445E-09

(b) Predicted PC (Table 5-7 of U.S. EPA, 1992a).

U-25 DAILY INTAKE · CHILD SURFACE WATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Alpena CRTC, Alpena, MI

Intake Rate (mg/Kg-day) 7.940E-09 Conversion
Factor
[l/cu cm]
0.001 Averaging Time (days) 25550 Body Weight (kg) Exposure Duration (years) (hrs/day) 2.6 Time Exposure Exposure Frequency [days/year] 48 Skin Surface Area (sq cm) 13300 Dermal
Permeability
(cm/hr)
0.022 Chemical
Concentration
(mg/kg)
1.000E-05 **a** Carbon Tetrachloride Chemical

(b) Predicted PC (Table 5-7 of U.S. EPA, 1992a).

TABLE U-26 CANCER ESTIMATE - SEDIMENT INGESTION FUTURE LAND USE SCENARIO - RECREATIONAL ADULT AND CHILD

								Adult		Child	
	Adult	Child	CD					Chemical	Total	Chemical-	Total
	CDI	CDI	Adjusted for	St	Weight of	Type of	SF	Specific	Pathway	Specific	Pathway
Chemical	(mg/kg-day) (r	(mg/kg-day)	Absorption	(mg/kg-day)*-1 Evidon	Evidence : Relative Potentcy Factor	Cancer	Source	Risk	Risk	Risk	Risk
Anthracene	7.716E-08	1.728E-07	ON	NO EVIDENCE	NA	NA	NA	0E+00		0E+00	
Benzo(a) anthracene	7 716E-08	1.728E-07	ON	7.3	B2 / 0.1	Liver and Lung	(a)	6E-08		1E-07	
Вяпго(а) ругеле	7 716E-08	1.728E-07	92	7.3	82 /1.0	Fore Stomach	(a)	6E-07		1E-06	
Benzo(b)fluoranthane	7.716E-08	1.728E-07	9	7.3	B2 /0 1	Lung, thorax, Liver	(a)	6E-08		1E-07	
Benzo(ahi) perylena	7 716E-08	1.728E-07	ON	NO EVIDENCE	NA	AN	AN A	0E+00		0E+00	
Benzo(k)fluoranthene	7.716E-08	1.728E-07	9	7.3	82/001	Lung, thorax, liver	(a)	6E-03		1E-08	
Butyl benzyl phthalate	3 690E-08	8.266E-08	9	NO EVIDENCE	AN	NA	AN.	00+30		0E+00	
Carbazole	7.716E-08	1.728E-07	ON N	NO EVIDENCE	NA	AN	AN	0E+00		0E+00	
Chrysene	7.716E-08	1.728E-07	9	7.3	B2 /0.001	Liver, lung	(a)	6E-10		1E-09	
Di n-butyl phthalate	7.716E-08	1.728E-07	ON.	NO EVIDENCE	Ϋ́Z	. AN	AN	0E+00		0E+00	
Fluoranthene	3.690E-08	8.266E-08	9	NO EVIDENCE	AN	AN	AN.	0E+00		0E+00	
Indeno(1,2,3.c,d)pyrene	7.716E-08	1.728E-07	ON	7.3	B2/01	٩Z	(a)	6E-08		1E-07	
Lead	1.188E-05	2.660E-05	9	NO DATA	AN	٩Z	AN	0E+00		0E+00	
Phonanthrene	3 690E-08	8.266E-08	ON N	NO EVIDENCE	AN	NA	AN	0E+00		0E+00	
Pyrene	3.690E-08	8.266E-08	ON N	NO EVIDENCE	NA	AN	NA	00+400		0E+00	
Selenium	1 543E-07	3.457E-07	ON	NO EVIDENCE	NA	NA	NA	0E+00		0E+00	
								0E+00		0E+00	
Total									11		00 10

TABLE U-27 SUBCHRONIC HAZARDOUS INDEX ESTIMATE - SEDIMENT INGESTION FUTURE LAND USE SCENARIO - RECREATIONAL ADULT AND CHILD

	1	-	1500	CITT OTHE				Adult		Child
	Aguit	Colid	100	GRS	Catical	RED	Modifying	Chemical-	Total Chamical	hemical
	in .	100	Adjusted for	(wd.kd-day)	Uffect	Source	Factor	Spacific	Pathway	Specific
CAMPICAL	(mg/kg-day) (mg/kg-day)	(mg/kg_day)	Absorption					Diek	Diak	Dist.
Anthracano	2.16E-07	2 02E-06	9	80	No observed effects	RIS 93	+	70 DC	Mak	TISK TO TO
Benzo(a) anthracene	2.16E-07	2.02E-06	ON	0.03	NA	(2)	- *	10-11		00-01
Benzolalaviene	2 16F-07	2 02F-06	ON	000		(a)	-	/E-Up		/E-05
Benzuthillioranthood	2 465 07	30 110 0	2 2	0000	A	(a)	+	2E-06		7E-05
organism and man	2.100-01	2.025-00	02	0.03	NA	(a)	-	7E-06		7F-05
Benzo(glw) perylene	2.16E-07	2.02E-06	02	0.03	NA	(a)	-	7F_06		7E.05
Renzo(k)fluoranthone	2.16E-07	2.02E-06	ON.	0 03	NA.	(6)		100		1 1
Butyl bonzyl phthalate	1.03E-07	9.64E-07	ON	NOT AVAILABLE	42		- 4	1 5-00		/E-03
Carbazole	2.16E-07	2.02E-06	ON	NOT AVAILARLE	V	<u> </u>	2 2			
Сhrysana	2.16E-07	2.02E-06	ON	AN	Q N	12	471			
Di-n-butyl phthalate	2.16E-07	2.02E-06	2	10	Increased mortality	IBIC 03	•	L		
-luor anthona	1 03F-07	9 64F-07	S		A COST CONTRACTOR	2000	-	2E-06		2E-05
Indone/1 2 2 c diameter	10 TO TO TO TO	20 1000	2 7	*0.0	Neophropathy	IKIS 93	q	3E-06		2E-05
dellov v, z, s-c, upyrene	Z. 16E-U/	2.02E-06	S	0.03	NA	(a)	AN	7F-06		7E.05
Lead	3.33E-05	3 10E-04	02	NO DATA	AN	, V	2			
Phenanthrene	1.03E-07	9.64E-07	ON	0.03	AM	(4)	(*	L		1
Pyrene	1 03F-07	9 64F-07	CN	0.00	<	(a)	1	35-06		3E-05
Solonium	A 305 07	A 02E 06	2 2	0.03	A	(a)	NA	3E-06		3E-05
2003000000	4.32E-07	4.USE-US	ON.	0.005	Clinical Scelhosis	IRIS 93	VN	905.05		AF-OA

(a) Chronic RfD for pyrene was used, Source IRIS 93

TABLE U.28 CANCER ESTIMATE: DERMAL CONTACT WITH SEDIMENTS FUTURE LAND USE SCENARIO

	Ξ
	ig Area, Albena CRTC, Albena
	CRIC
	Albena
	Area.
	ainir
	Fire
	irst
	id Waste Landfill and First Fire Tr
	Site 6 & 7, Former Solid Waste
cts	SS S
Fff	-orme
Bhio	7
nog	89
arci	š
٥	

	A dista							Adult	Child	
	Adult	ביייים	(10)					Chemical-	Total Chemical	Total
	IO.	CDI	Adjusted for	25	Weight of	Type of	SF	Specific	Pathway Specific	Dathway
Chemical	(mg/kg-dey)	(mg/kg-day)		(mg/kg-day)*-1	Evidence	Cancer	Source	Riek	Rick Rick	Apid
Anthracene	1.667E-06	1 238E-06	YES NO	NO EVIDENCE	NA	AN	AN	0 000E+00	00000	1000
Banzo(a)anthracene	1.667E-06	1.238E-06	YES	43	82 /01	liver and line	(6)	7 4600 06	00.7000.0	
Benzo(a)pyrane	1.667E-06	1.238E-06	YES	S 43	B2 /10	TOO CLOSE CANADA	(B) (S	7 4505-00	3.323E-06	
Renzolbitingranthana	1 667E-06	1 23RE-06	VEC	73	7 9 00	10000	(B)	7.169E-03	5.3256-05	
	00 1100	So Locc	012		1.07.70	Lung, morax, Liver	(B)	7.169E-06	5,325E-06	
Benzo(gni)paryione	1.66/E-U5	1.238E-Ub	TES NO	EVIDENCE	A.V.	AZ.	∀ Z	7,169E-05	5 325F-05	
Benzo(k)fluoranthene	1.667E-06	1.238E-06	YES	43	B2 / 0.01	Euno, thorax, liver	(e)	7 169E-07	5 3355 67	
Butyl benzyl phthalate	7.973E-07	5 923E-07	YES NO	S NO EVIDENCE	NA	AN.	47	3 428E-05	3.323E-01	-
Carbazole	1.667E-06	1.238F-06	YES		♥ N	-	414	3.420E-03	Z.347 E-03	
	4 6675 06	1000		,		T	Y Z	0.000E+00	0.000E+00	
Curysaile	90-3 /99	1.230E-UB		11	100.07.28	Liver, lung	(8)	1.834E-08	1 362E-08	
Di-n-butyl phthalate	1.667E-06	1.238E-06	YES NO) EVIDENCE	A'N	AN	ĺΝ	000000	00-1700-0	
Fluoranthene	7.973E-07	5 923E-07	YES NO	PVIDENCE	ΔIA	-		000000	0.000=+00	
Indonest 2.2 a dimercan	1 6675.00	1 2200 00		43			1	O.DOUE+00	0.000E+00	
mannot t, z, o c, u)pyrama	1.007 E-00	500 TOO		42	B2/ U.1	NA	(a)	7.169E-06	5 325E-06	
Lead	1.026E-05	7.625E-06		NO DATA	AN	ΑN	AM	00000	00730000	
Phenanthrene	7.973E-07	5.923E-07	YES NO	NO EVIDENCE	NA.	₩.	V 4	00.11000.0	0.00000	
	70775 07	E 022 03		10000			2	0.000E+00	0.000E+00	
Pyrene	10-3135-01	3.322E-07		LAIDENCE	AN	AZ.	ΑN	0.000E+00	0 000 0	
Selenium	1.334E-07	9.908E-08	YES NO	SEVIDENCE	NA NA	NA	Ϋ́	0.0005+00		
Total									25 04	L

al SF for pyrane used for all PAHs.
Adjusted from administrand to absorberd dose assuming oral absorption efficiencies Chrysene 0.67(ASTDR, 1990), all PAHs 0.17 (ASTDR 1990), di-n-butyl phihalate 0.8 (ASTDR 1990),Se 0.935 (ASTDR 1989)

TABLE U-29 CANCER ESTIMATE. DERMAL CONTACT WITH SEDIMENTS FUTURE LAND USE SCENARIO

								Adult		7190	
	Artist	Child	IU.								
	1000	70.7	A Error I C	. 000				Chemical-	Total	Chemical.	Total
		ICI'S	Adjusted for	5413	Critical	RHD	Modifying	Specific	Pathway	Specific	Pathway
emical	(mg/kg-day)		Absorption	(mg/kg day)	(, ffnet	Source	Factor	Rick	Diek	Diet	Ö
Anthracene	4 668E-06	6 5.779E-06	YES	0.05	No observed effects	1818 93	+	93365 05	Nen	4 45.01 04	SIZ
3enzo(a)anthracene	4.668E-05	5.779E-06	YES	0.005	NA	(6)	- **	0.3300-03		4 4FOT 02	
3enzo(a)pyrene	4.668E-06	5.779E-06	YES	0.005	Ø.V	(c)	- •	10-110000 10-110000		1.1555-03	
Senzo(b)fluoranthene	4 668E-06	47	Y F.S	0 005	~~~	(0)	- ,	9 336E-04		1.156E-U3	
Benzo(ghi)parylana	4.668E-06		VE'S	0.005	*	(9)	- •	9.336E-04		1.156E-03	
Bonzo(k)fluoranthene	4.668E-06		YES	0.005	V	(B)	- +	9.336E-04		1.156E-03	
Butyl banzyl obthalate	2 232F-06		SUA	0.005		(9)	- :	9.335E-04		1.156E-03	
Corporole	SO THE SECOND			0000	***	¥Z.	NA	4.465E-04		5.528E-04	
Datala	4.666E-U		YES		NA	٧Z	AN				
Chrysene	4.668E-06		YES	0.02	₹ Z	AZ		2 334E-04		2 000 0	
Di-n-butyl phthalato	4 668E-06	5.779E-06	YES	0.08	Increased mortality	1818.93	•	5 935E 06		7 2241 05	
luoranthono	2 232E-06		VES	0.007	Macohropothy	20 0101		2000000		1.24E-U3	
and and the contract of the same	00 (1000 V		000		recepture princip	06 0121	-	3 189E-04		3 949E-04	
another, c, o. c, appyrana	4.650E-U		750	600.0	FIA	(a)	NA	9.336E-04		1 156F-03	
pae-	2.874E-05	<u>~</u>	YES	NO DATA	₹Z	AN	V.				
Phenanthrone	2.232E-06	3 2.764E-06	YES	0.005	4	(6)	2	A ARSE.OA		A FOOT OA	
Pyrana	2.232E-06	2	YES	0.005	AN	(a)	ΨN	4.465E-04		5.528E-04	
Solenium	3,734E-07	7 4 624E-07	YES	0.005	Chairal Scalageis	1010101	414	1000		0.02020	

Adjusted from administrated to absorbered doso assuming and absorption officiancies Chrysmu 0.67(ASTDR, 1990), all PAHs 0.17 (ASTDR, 1990), di n buryl platbalare 0.3 (ASTDR 1990), So 0.935 (ASTDR 1989) a) Chronic RIO for prune used for all PAHs.

TABLE U-30 CANCER ESTIMATE - FISH INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Chemical	Adult CDI (mg/kg-day)	Adult Child CD CDI (mg/kg-day) (mg/kg-day)	CDI Adjusted for Absorption (mg/	SF /kg-day}*1	Weight of Evidence	iype of Cancir	Spurce	Adult Chemical Specific Risk	Total Pathway	Children Chemical- Specific	Total Pathway
Carbon latrachlorida	1.668E-09	2.066E-09	ON.	0.13	82	heptocelluar cardinomas	IRIS, 1993	2.169E-10		2.686E-10	No.

TABLE U-31 CHRONIC HAZARDOUS INDEX ESTIMATE - FISH INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

RID Modifying Specific Pathway Specific Pathway Specific Pathway	Citical RID Modifying Specific Pathway Specific I Source Source Fisk Risk Risk Risk Risk Risk Liver RIS, 1993 1 6.673E-06 1.378E-05
Uver Files Files	Hilord Source Nork Pisk Pisk Pisk Hisk His
00/5E700 1 2320 1 2550 1 2570 1 2570 1 2570 1 2570 1 2570 1 2570 1 2570 1 2570 1 2570 1 2570 1 2570 1 2570 1 2	LVD. 1395 0.01/2E-00

TABLE U.32 CANCER ESTIMATE - SURFACE WATER INDESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Carcinogenic Effects Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area, Apena CRTC, Alpena, Mi

1 784E_10		1.134F-10									
	1.784E-10		1.134E-10	IRIS, 1993	heptocellular carcinomas	82		O <u>x</u>	1,357E-09	8.722E-10	Carbon Tetrachloride
Risk	Risk	Risk	Risk	Source	Cancer	Evidence	(mg/kg-day)^-1	Absorption	(mg/kg-day)	(mg/kg-day) (mg/kg-day)	Chemical
Pathway	Specific	Pathway	Specific	AS.	Type of	Weight of		Adjusted for	CDI	CDI	
Total	Chemical-	Total	Chemical-					CDI	Child	Adult	
	Children		Adult								

TABLE U-33 CHRONIC HAZARDOUS INDEX ESTIMATE - SURFACE WATER INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Chemical	Adult Child CD1 CD1 CD1 (mg/kg-day) (mg/kg-day)	Child CDI (mg/kg-day)	CDI Adjusted for Absorption	RfD (ma/ka-dav)	Critical Effect	RFD	Modifying	Adult Chemical- Specific Pick	Total Pathway	Chemical- Specific	Total
Carbon Tetrachloride	2.442E-09	2.442E-09 6.332E-09	ON	0.0007	Liver	IRIS, 1993	-	3.489E-06	201	9.045E-06	480

TABLE U-34 CANCER ESTIMATE - SURFACE WATER DERMAL FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Carcinogenic Effects Site 6 & 7, Former Solid Waste Landfill and First Fire Training Area.	aste Landfill and F					And the second s					
								Adult		Children	
	Adult	Child	CDI					Chemical-	Total	Chemical-	Total
	CDI	CDI	Adjusted for	SF •	Weight of	Type of	SF	Specific	Pathway	Specific	Pathway
Chemical	(mg/kg-day) (mg/kg-day)	(mg/kg-day)	Absorption (m	(mg/kg-day) -1	Evidence	Cancer	Source	Risk	Risk	Risk	Risk
Carbon Tetrachloride	7.445E-09	7,940E-09	YES	1.44E-01	B2	heptocellular carcinomas	IRIS, 1993	1.075E-09		1.147E-09	

1.147E-09

^{*} Adjusted from administered to absorbed dose using and efficiency of 0.90 (ATDSR, 1992).

TABLE U.35 CHRONIC HAZARDOUS INDEX ESTIMATE - SURFACE WATER DERMAL FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncarcinogenic Effects

The state of the s	א באמנה רשווחווו שווח	A RIMINE LI LI RIMINE IN LA	maining Area, Apena CAIC, Apena, Mi	Aperta, Mi						
	Adult	Child	* CDI					Adult		Children
	CDI	CDI	Adjusted for	RfD •	Critical	RfD	Madifying	Spacific	Pathway	Chemical-
Chemical	(mg/kg-day)	(mg/kg-day) (mg/kg-day)	Absorption	(mg/kg-day)	Effect	Source	Factor	Risk	Rick	Nie in
Carbon Tetrachloride	2.085E-08	3.705E-08	YES	0,00063	Liver	IRIS, 1993		3.309E-05		5.882E-05
									3.309E-05	

Total Pathway Risk

Adjusted from administered to absorbed dose using and efficiency of 0.90 (ATDSR, 1992).

Groundwater Solute Transport Model Data - Site 6/7

Theoretical Background

A two-dimensional Method of Characteristics (MOC) solute transport model (Konikow and Bredehoeft, 1989) was used for preliminary examination of contaminant migration within the shallow aquifer beneath the Alpena CRTC. The model is designed to calculate transient changes in solute concentrations within groundwater by simultaneously solving partial differential equations describing groundwater flow and transport and computes the change in a chemicals concentration over time. Changes in chemical concentrations over time are caused by the processes of convective transport, hydrodynamic dispersion, and mixing from fluid sources. This model couples the groundwater flow equation with solute transport equations.

The flow equation can be approximated by an implicit finite-difference equation. The model area is discretized into a rectangular grid with each square being a node. The finite difference equation is solved numerically for each node in the grid using an iterative alternating-direction implicit (ADI) procedure.

After the hydraulic head distribution is calculated, the velocity of groundwater flow can be computed at each node. The expression for average velocity of groundwater can be derived from Darcy's law. The groundwater velocity at each node is calculated utilizing an explicit finite-difference approximation of Darcy's law. The computer program uses an alternating-direction implicit procedure to solve a finite-difference approximation to the groundwater flow equation, and it uses the method of characteristics (MOC) to solve the solute transport equation. MOC uses a particle tracking procedure to represent convective transport and a two-step, explicit procedure to solve a finite-difference equation that describes the effects of hydrodynamic dispersion, fluid sources and sinks, and divergence of velocity.

A number of assumptions are inherent in the solute transport model:

- 1. Darcy's law is valid and hydraulic head gradients are the only significant driving mechanism for fluid flow.
- 2. The porosity and hydraulic conductivity of the aquifer are constant with time, and porosity is uniform in space.
- 3. Gradients of fluid density, viscosity, and temperature do not affect the velocity distribution.
- 4. No chemical reactions occur that affect the concentration of the solute, the fluid properties, or the aquifer properties.
- 5. Ionic and molecular diffusion are negligible contributors to the total dispersive flux.
- 6. Vertical variations in head and concentrations are negligible.

7. The aquifer is homogeneous and isotropic with respect to the coefficients of longitudinal and transverse dispersivity.

Transport Model Input

A model grid of 32 columns by 19 rows with a 250 foot lateral spacing was used. Specified head cells were used at nodes corresponding to the South Branch of the Thunder Bay River, at nodes along the eastern boundary of the model grid area, and also at the sinkhole in the northeastern portion of the model. Groundwater elevations measured during September, 1993 were used as initial input into the transport model. Hydraulic conductivity values were calculated from slug tests performed at Alpena CRTC (Engineering Science, 1989; Earth Technology, 1994). Values of hydraulic conductivity range from 12 feet/day at Site 4 to 278 feet/day at Site 3.

Aquifer thickness values were obtained from drilling records of monitoring wells and soil borings obtained from the SI and RI field activities. Values listed are from logs in which the thickness of the shallow aquifer was clearly discernible, and ranged from 20 feet at Site 5 to 65 feet at Site 8. Transmissivity values were calculated by multiplying the calculated hydraulic conductivity values by the aquifer thickness. Transmissivity ranges from 420 ft²/day at TF4-MW3 to 15,290 ft²/day at CG3-MW5.

Monitoring of the discharge of springs into the sinkhole was performed during the SI (Engineering Science, 1990) and an estimate of approximately 18,000 gallons of water per day discharging into the sinkhole was calculated. In order to obtain a numerical estimate of discharge into the sinkhole for the model, MODFLOW (McDonald and Harbaugh, 1988), a 3- dimensional finite-difference groundwater flow model was used. MODFLOW was used because of its ability to simulate the effect of head-dependent groundwater flow into a groundwater sink (i.e. the sinkhole). This package was not available in MOC. The same model parameters and boundary conditions were used within MODFLOW as in MOC. Based upon hydraulic head data collected in September 1993, discharge from the shallow aquifer into the sinkhole is approximately 30,000 gallons per day.

The dispersivity of an aquifer in two dimensions is described by the longitudinal dispersion, the transverse dispersion and the ratio of the two (Fetter, 1993). As a contaminant plume moves further from its initial location within the aquifer by advection with the groundwater flow, the plume spreads. The spreading in the direction of groundwater flow is the longitudinal dispersion, the spreading in the direction perpendicular to the groundwater flow is known as the transverse dispersion (Fetter, 1993). The values of the dispersion coefficients are typically derived via bench scale tests, aquifer tests, or calibration of contaminant transport models. Since no data presently exists describing dispersivity within the shallow aquifer beneath the Alpena CRTC and insufficient data exists to allow for derivation of dispersivity via model calibration, moderate values of 100 feet for longitudinal dispersivity and 30 feet for transverse dispersivity were chosen (Gillham and Cherry, 1982). A more complete description of the model is given in the report, Preliminary Groundwater Modeling Effort, Earth Technology, August 1993.

Model Calibration:

The groundwater flow model was calibrated with respect to the September 1993 groundwater elevation measurements. Calibration of the groundwater flow model was accomplished by defining a set of parameters, boundary conditions, and stresses that produce simulated heads and fluxes that match field-measured values within a preestablished range of error (Anderson and Woessner, 1992). In order to match field measured values for hydraulic head as determined during September 1993, a few modifications were made to the preexisting groundwater flow model. These changes included updating the initial head array, modeling the sinkhole as a constant head cell to account for the large gradient changes in the vicinity of the sinkhole and including recharge to the model at a rate of 9 inches per year over the whole model area. By adjusting these parameters, an acceptable level of calibration was achieved. An acceptable level of calibration was defined as a root mean squared error (RMS) of less than 2 feet. The RMS, or the standard deviation is the average squared difference in measured and simulated heads and is given by the equation:

RMS=
$$\left[1/n\sum_{i=1}^{n} (h_m - h_s)_{i}^{2}\right]^{0.5}$$

n = number of wells $h_m = measured head$ $h_s = model simulated head$

Certain portions of the model may have values above the goal of 2 feet while others fall much below this value. The RMS represents the average error present in the model. The following provides a summary of the final calibrated heads for the flow model.

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
MP2MW1	10,25	679.69	676.68	3.01
MP2MW3	10,22	675.51	675.46	0.05
MP2MW4_5*	11,23	675.34	675.70	-0.36
MP2MW6	11,20	674.86	674.52	0.34
CG3MW1	6,24	677.38	676.69	0.69
CG3MW2	7,22	676.29	675.78	0.51
CG3MW3	9,23	676.50	675.98	0.52
CG3MW4_5*	8,23	676.41	676.08	0.33

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
CG3MW7	8,20	675.64	674.80	0.84
TF4MW1	7,9	667.23	668.83	-1.60
TF4MW2	8,10	659.61	664.22	-4.61
TF4MW3_4*	9,10	658.21	660.06	-1.85
SF5MW1	12,6	674.15	671.34	2.81
SF5MW2	14,5	675.32	672.67	2.65
SF5MW3_4*	13,6	676.46	671.64	4.82
SF5MW6	13,5	674.26	672.40	1.86
LF6MW1	14,9	672.1	670.40	1.70
LF6MW2	14,8	672.68	670.72	1.96
LF6MW3	14,10	671.93	670.21	1.72
LF6MW4	16,7	672.75	671.91	0.84
LF6MW5	15,7	673.07	671.56	1.51
LF6MW6	13,10	671.17	669.67	1.50
LF6MW8	15,9	673.12	670.78	2.34
HN8MW1	5,22	676.96	675.93	1.03
HN8MW2	6,19	675.31	674.50	0.81
HN8MW3_4*	7,21	676.01	675.35	0.66
RT9MW1	6,16	673.06	672.78	0.28
RT9MW2	7,14	668.21	670.81	-2.60
RT9MW3	9,15	670.72	671.26	-0.54
RT9MW4_5*	8,14	667.47	670.32	-2.85
RT9MW6	8,16	670.58	672.33	-1.75
S1MW2	13,26	677.39	676.63	0.76
S1MW3	13,27 -	677.15	676.98	0.17
S1MW11	15,24	675.72	675.67	0.05
S1MW12	16,25	674.55	675.94	-1.39

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
S1MW13	14,24	675.21	675.76	-0.55
S1MW14	14,25	673.92	676.14	-2.22
MP2MW2	12,24	675.57	675.96	-0.39

* Indicates that more than one well is present in each node and an average value for hydraulic head was used.

Sum of Squared Residuals = 128.78/38 = 3.3891 Root Mean Squared Error = 1.84

It should also be noted that the model was calibrated with respect to the September 1993 water level data and should only be considered calibrated with respect to this data. More information on the water level fluctuation through time would be needed to perform a transient calibration. The model was not calibrated with respect to concentration data, but only with respect to hydraulic head.

Model Assumptions and Limitations

- * The model domain consisted only of the shallow unconfined aguifer (i.e. one layer).
- * The initial head data input to the transport model are results of measurements taken in September 1993.
- * Initial concentrations of compounds are results of the Round IV sampling event which was conducted from July to September 1993.
- * Hydraulic conductivity values are the result of slug tests performed in November, 1987 and September 1993.
- * The model was calibrated with respect to hydraulic head using September 1993 water level data and should only be considered calibrated with respect to September 1993 water level data.
- * The flow model was assumed to be at steady-state with respect to hydraulic head.

Site 6

Carbon Tetrachloride was present in LF6MW3 above MDNR Type B cleanup criteria at a concentration of 1.2 ug/l. This data was input to the model and concentrations were monitored along the backwater area of Lake Winyah and at the sinkhole with respect to time.

Appendix V: Site 8 Risk Assessment

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Groundwater - Site 8 MIANG, Alpena CRTC, Alpena, MI Table V-1A

H H		C C			
7	LOCA OA	SAIMPLE ID	MAIKIX	ANALYTE	RESULT
PC-HN8	MW1	PC-HN8-MW1-GW4	GROUNDWATER	Tetrachloroethylene	0 1500
PC-HN8	MW2	PC-HN8-MW2-GW4	GROUNDWATER	Tetrachloroethylene	0.1500
PC-HN8	MW3	PC-HN8-MW3-GW		Totrooblossothulese	0.1300
	7 0 10 11			i ett actilloloetriylene	1.2000
	IMIVV4	PC-HN8-MW4-GW4	GROUNDWATER	Tetrachloroethylene	0 1500
PC-HN8	MW5	PC-HN8-MW5-GW4	GROUNDWATER	Tetrachloroethylene	0.4500
					000

Table V-2A
Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Soil - Site 8
MIANG, Alpena CRTC, Alpena, MI

SITE	LOCATOR	SAMPLE ID	MATRIX	ANALYTE	SAMPLE DEPTH RANGE	ir.	RESULT
C-HN8	SB4	PC-HN8-SB4-SS00-02	SOIL	Antimony		0000	2.3500
PC-HN8	SB6	PC-HN8-SB6-SS00-02	SOIL	Antimony		200	5 1000
PC-HN8	SB7	PC-HN8-SB7-SS00-02	SOIL	Antimony		000	2.4000
PC-HN8	SB4	PC-HN8-SB4-SS00-02	SOIL	Lead		200	2 2000
PC-HN8	SB6	PC-HN8-SB6-SS00-02	SOIL	Lead	0.0000	2000	42 6000

SITE8V.WB1/940126

TABLE V-1 EXPOSURE ASSESSMENT PARAMETERS - INGESTION OF GROUNDWATER Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

	RECREATIONAL	RECREATIONAL	
PARAMETER	ADULT	CHILD	
Ingestion Rate (L/day)	2	2	
Exposure Frequency (days/year)	298 *	48	
Exposure Duration (years)	25	15	
Body Weight, Kg	70	27	
Averaging Time			
Carcinogens	70	20	
Noncarcinogens	25	15	

Worst case scenario assumes that the adult is present on-site 250 days /year as a worker and 48 days per year for recreation

TABLE V.2 DAILY INTAKE - ADULT INGESTION OF GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Chemical	Chemical Concentration (mg/l)	Ingestion Rate (Ldav)	Exposure Frequency (dava/vear)	Exposure Duration	Body Weight	Averaging	Intake Rate
Tefrachloroethylene	8.077E-04	2	298	25	07	9125	1.884E-05

TABLE V.3 DAILY INTAKE - CHILD INGESTION OF GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Chemical	Chemical Concentration (mg/kg)	Ingestion Rate (Uday)	Exposure Frequency (days/year)	Exposure Duration (vears)	Body Weight	Averaging Time	Intake Rate
etrachloroethylene	8.077E-04	2	48	15	27	5475	7.868E-06

TABLE V.4 DAILY INTAKE - ADULT INGESTION OF GROUNDWATER FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Chemical	Chemical Concentration (mg/l)	Ingestion Rate	Exposure Frequency (days/hear)	Exposure Duration	Body Weight	Averaging Time	Intake Rate
retrachloroethylene	8.077E-04	2	298	25	70	25550	6.729E-06

TABLE V-5 DAILY INTAKE - CHILD
INGESTION OF GROUNDWATER
FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, Mi

Chemical	Chemical Concentration	Ingestion Rate	Exposure Frequency	Exposure Duration	Body Weight	Averaging	Intake Rate
	(mg/kg)	(Uday)	(days/year)	(years)	(kg)	(days)	(mg/Kg-day)
Tetrachloroethylene	8.077E-04	И	48	₹	27	25550	1.686E-06

TABLE V-6 EXPOSURE ASSESSMENT PARAMETERS - INHALATION OF GROUNDWATER Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

	RECREATIONAL	RECREATIONAL	
TANAMIE I EN	ADULT	CHILD	
Exposure Time (hours/day)	0.12	0.12	
Inhalation Rate (cu m/hr)	9.0	90	
Exposure Frequency (days/yr)	298	48	
Exposure Duration (years)	25	15	
Body Weight, Kg	20	7.6	
Averaging Time		i	
Carcinogens	70	20	
Noncarcinogens	25	15	

[&]quot;Worst case scenario assumes that the adult is present on-site 250 days fyear as a worker and 48 days per year for recreation

TABLE V.7 DAILY INTAKE - ADULT INHALATION OF GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, Mi

Chemical	Chemical Concentration	Inhalation Rate	Exposure Frequency	Exposure Time	Exposure Duration	Body Weight	Averaging Time	Intake Rate
Tetrachloroethylene	7.630E-03	9.0	298	0.12	25	70	9125	6.407E-06

TABLE V.8 DAILY INTAKE - CHILD INHALATION OF GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

	Chemical	Inhalation	Exposure	Exposure	Exposure	Body	Averaging	Intake
Chemical	Concentration (mg/cu m)	Rate (cu m/hr)	Frequency (days/vear)	Time (hours/dav)	Duration (vears)	Weight (kg)	Time (days)	Rate (mg/Kg-dav)
Tetrachloroethylene	7.630E-03	9.0	48	0.12	15	27	5475	2.676E-06

TABLE V.9 DAILY INTAKE - ADULT INHALATION OF GROUNDWATER FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Chemical	Chemical Concentration (mg/cu m)	Inhalation Rate (cu m/hr)	Exposure Frequency (days/year)	Exposure Time (hours/day)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (dava)	Intake Rate (mg/Kg-day)
l etrachloroethylene	7.630 E- 03	9.0	298	0.12	25	70	25550	2.288E-06

TABLE V-10 DAILY INTAKE - CHILD INHALATION OF GROUNDWATER FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 8: Former Site of Handar 9. Albena CRTC. Albena. M

Side of Purrier Side of Clari	one o, horner one or hangar e, Alpena CKIC, Alpena, MI							
Chemical	Chemical Concentration (mg/cu m)	Inhalation Rate (cu m/hr)	Exposure Frequency (days/year)	Exposure Time (hours/dav)	Exposure Duration (vears)	Body Weight	Averaging Time	Intake Rate
Tetrachloroethylene	7.630E-03	9.0	48	0.12	15	27	25550	5.734E-07
-								

TABLE V-11 GROUNDWATER INHALATION MODEL CALCULATIONS Site 8, Former Site of Hangar 9, Alpena GRTC, Alpena, MI

Chemical Fraction Water Flow	oue O	st snowering			During and Arter
Volatilizad		DOLARION	Bathroom	Contaminant	Showering MAX Contaminant
A OLDRING A	te Period	Period	Volume	Concn'n in Air	Canen'n in Air
(mg/L) (unitless) (L/hr)	(hr)	(hr)	(cn m)	(mg/cn m)	(mg/cn m)
77E-04 0.7 750	50 0.25	0.35	11	9.638E-03	7.630E-03
0.7		0.35	11		9.638E-03

SITE8A.WB1/ 940127

TABLE V-12 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH GROUNDWATER Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

	DECREATIONAL	TAMOLT A TOCALO	
DADAMOHID		JANOL AUKOUK	_
PANAIMETER	ADULT	CHILD	
Skin Surface Area Available for Contact (sq cm)	19400	13300	
Exposure Time (hrs/day)	0.25	0.25	
Dermal Permeability Constant *	0.00084	0 00084	
Exposure Frequency (days/year)	298	488	
Exposure Duration (years)	25	t t	
Body Weight, Kg) Z	7.0	
Averaging Time		i	
Carcinogens	70	02	
Noncarcinogens	25	15	
Conversion Factor	0.001		

"Worst case scenario assumes that the adult is present on-site 250 days /year as a worker and 48 days per year for recreation

TABLE V-13 DAILY INTAKE - ADULT GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO

Noncarchogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Chemical	*	Chemical Concentration (mg/l)	* Dermal Permeability (cm/hr)	Skin Surface Area (sq cm)	Exposure Frequency (days/year)	Exposure Time (hrs/day)	Exposure Duration (years)	Body Weight (kg)	Averaging Time (days)	Conversion Factor (I/cu cm)	intake Rate (mg/Kg-day)
retrachloroethylene	(a)	8.077E-04	0.4		298	0.25	25	07	9125	0.001	1.828E-05

^{* (}a) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992).

TABLE V-14 DAILY INTAKE - CHILD GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO Noncarcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Chemical	•	Chemical Concentration (mg/l)	* Dermal Permeability (cm/hr)	Surface Area	Exposure Frequency	Exposure Time	Exposure Duration	Body Weight	Averaging Time	Conversion Factor	Intake
Tetrachloroethylene	(a)	8.077E-04	0.4		48	0.25	15	27	5475	0.001	5.232E-06

^{*(}a) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992).

SITE8A.WB1/ 940127

TABLE V-15 DAILY INTAKE - ADULT GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, Mi

hemical	*	Chemical Concentration (mg/l)	* Dermal Permeability (cm/hr)	Skin Surface Area (sq.cm)	Exposure Frequency (days/year)	Exposure Time (hrs/day)	Exposure Duration (vears)	Body Weight	Averaging Time (days)	Conversion Factor	Intake Rate (ma/Koday)
trachloroethylene	(a)	8.077E-04	0.4		298	0.25	25	07	25550	0.001	6.527E-06

^{* (}a) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992).

TABLE V-16 DAILY INTAKE - CHILD GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO Carcinogenic Effect Exposure Assessment

(cm/hr) (sq.cm) (days/year) (hrs/day) (years) (kg)	Chemical	•	_	* Dermal Permeability	Skin Surface Area	Exposure Frequency	Exposure	Exposure Duration	Body Weight	Averaging	Conversion Factor	intake Rate
(a) 8.077E-04 0.4 13300 48 0.25 15 27 25550 0.001				(cm/hr)	(sd cm)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(I/cn cm)	(mg/Kg-day)
	i etrachioroethylene	(8)		9.0	13300	48	0.25	15	27	25550	0.001	1.121E-06

^{*(}a) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992).

TABLE V-17 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH SOILS Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

	- ACCASSACIATION	TTIO 140	Drond a Tiostia	14014014	
PARAMETER	WORKER	ON-SITE ADULT	ADULT ADULT CHICKEATIONAL	RECKEATIONAL	
Skin Surface Area Available for Contact (cm/2/day)	3120	3120	3120	1490	
Soil to Skin Acherence Factor (mg/cm^2)	2.77	2.77	2.77		
Absorption Factor, Unitiess					
Metals	0.01	0 0 1	0.01	0.01	
Organics	0.25	0.25	0.25	0.25	
Exposure Factor (days/year)	250	250	298	48	
Exposure Duration (year)	0.08	25	25	15	
Body Weight (kilograms)	70	70	70	27	
Conversion Factor	1E-06	1E-06	1E-06		
Averaging Time, years					
Cardrogens	70	70	70	70	
Noncardinogens	0.08	25	25	15	

Recreational adult assumes the adult works at the recreational area 250 days/nr and participates in recreation another 48 days per year.

SITE8A.WB1/940127

TABLE V-18 DAILY INTAKE-ADULT
DERMAL CONTACT WITH SOILS
CURRENT LAND USE SCENARIO - ON-SITE EMPLOYEE

Conce		Conversion	Available	Soil to	Absorption		FYDOR	a de de	-	1
(III)	Concentration (mg/kg)	Factor (kg/mg)	Skin Surface (cm^2/day)	Skin Adherence	Factor		Duration	Weight	Time	Absorbed
Artimorry 5. Lead	5.100E+00 1.260E+01	1.00E-06 1.00E-06	3120 3120	2.77	0.01	250	25 25 25	70 70 70	9125 9125	(mg/kg-day) 4.313E-06 3.602E-05

TABLE V-19 DAILY INTAKE - ADULT
DERMAL CONTACT WITH SOILS
CURRENT LAND USE SCENARIO - ON-SITE EMPLOYEE

Cardnogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, M

Chemical	Chemical Concentration (mg/kg)	Corversion Factor (kg/mg)	Available Skin Surface (cm^22/day)	Soil to Skin Acherence (malcm²2)	Absorption Factor (unifiess)	Exposure Frequency (days/year)	Exposure Duration (vears)	Body Weight	Average Time	Absorbed Dose (molecular)
Artimony Lead	5 100E+00 4.260E+01	1.0E-06 1.0E-06		2.77	0.01	250 250	25 25	07 07	25550 25550	1.540E-06 1.287E-05

TABLE V-20 DAILY INTAKE - ADULT Dermal Contact with soils Future Land Use Scenario - Excavation Workers

Clemca	Concertration (mg/kg)	Conversion Factor (kg/mg)	Available Skin Sufface (cm^2/day)	Soil to Skin Acherence (malam2)	Absorption Factor	Exposure Frequency	Exposure Duration	Body Weight	Average Time	Absorbed
Artimony Lead	5.100E+00 4.260E+01	1.00E-06 1.00E-06	3120	2.77		250	0.08	02 02	29.2	4.313E-06 3.602E-05

TABLE V-21 DAILY INTAKE - ADULT
DERMAL CONTACT WITH SOILS
FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

	Ē
	Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI
	Ö
Ę	CRI
SE	ĕ
SSes	APP
ĕ	6
5	gar
8	Han
ij	5
ĭ	Site
2	je
g	6
롲	8
Ĕ	Site

Skin Acherence (mg/cm^2)	Factor Fre (unifiess) (da		TANK C	Body	Average	Absorbed
		equency	Duration	Weight	Time	Dose
		ays/year)	(years)	(kg)	(days)	(mg/kg-day)
		250	0.08	70	25550	4.929E-09
		250	0.08	70	25550	4 117E-08
	i			200		

TABLE V-22 DAILY INTAKE - ADULTS
DERMAL CONTACT WITH SOILS
FUTURE LAND USE SCENARIO - RECREATIONAL ADULT

Noncardinggeric Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, Mi

Chemical	Chemical	Conversion	Available	Soil to	Absorption	Exposure	Exposure	Body	Average	Absorbed
	Concertration	Factor	Skin Surface	Skin Acherence	Factor	Frequency	Duration	Weight	Time	Dose
	(mg/kg)	(kg/mg)	(cm^2/day)	(mg/cm^2)	(unitiess)	(days/year)	(years)	(kg)	(davs)	(malka-dav)
Lead Lead	5 T00E+00 4.260E+01	1.00E-06 1.00E-06		2.77	0.01	298 298	25 25	70 70	9125 9125	5.141E-06 4.294E-05

TABLE V-23 DAILY INTAKE CHILD
DERMAL CONTACT WITH SOILS
FUTURE LAND USE SCENARIO - RECREATIONAL CHILD

Noncardingeric Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpera CRTC, Alpera, MI

	i		1					Herti		
Chemical	Chemical Concertration (mg/kg)	Corversion Factor (kg/mg)	Available Skin Surface (cm^2/day)	Soil to Skin Adherence (ma/cm/2)	Absorption Factor (unifless)	Exposure Frequency	Exposure Duration	Body Weight	Average Time	Absorbed
Artimorry Lead	5.100E+00 4.260E+01	1.00E-06 1.00E-05		2.77	0.01	48	15	27 27	5475 5475	1.025E-06 1.025E-06 8.564E-06

FUTURE LAND USE SCENARIO - RECREATIONAL ADU Carcinogeric Effect Exposure Assessment

Site 8, Former Site of h	Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, Mi									
	Chemical	Conversion		Soil to	Absorption	Exposure	Exposure	Body	Average	Absorbed
Chemical	Concentration	Factor	Skin Surface	Skin Adherence	Factor	Frequency	Duration	Weight	Time	Dose
	(mg/kg)	(Kg/mg)		(mg/cm²2)	(nutess)	(days/year)	(years)	(KG)	(cays)	(Mag-by/bm)
Artimony	5.100E+00	1.0E-06		2.77	0.01	298	52	70	25550	1.836E-06
Lead	4.260E+01	1.0E-06		2.77	0.01	298	25	70	25550	1.534E-05

TABLE V-26 DAILY INTAKE CHILD DERMAL CONTACT WITH SOILS FUTURE LAND USE SCENARIO Cardinogenic Effect Exposure Assessment

Site 8, Former Site of	Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, Mi									
	Chemical	Conversion	Available	Soil to	•	Exposure	Exposure	Body	Average	Absorbed
Chemical	Concentration (mg/kg)	(kg/mg)	(cm^2/day)	Sign Agherence (mg/cm^2)	(uritless)	(days/year)	(years)	Weight (kg)	(days)	(mg/kg-day)
Antimony	5,100E+00	1.0E-06	1490	2.77		48	15	27	25550	2.197E-07
Lead	4.260E+01	1.0E-06	1490	2.77		48	15	27	25550	1.835E-06
										-

TABLE V.28 EXPOSURE ASSESSMENT PARAMETERS - SOIL INGESTION SIts 8, Former Site of Hangar 8, Alpena CRTC, Alpena, MI

PARAMETER	FACILITY EXCAVATION EMPLOYEE WORKER	EXCAVATION WORKER	RECREATIONAL ADULT	RECREATIONAL
Ingestion Rate (mg/day) Fraction ingested from	100	480	100	200
Contaminated Sources (unitiess)		-	•	
Exposure Frequency (days/year)	250	250	298	- 07
Exposure Duration (years)	25	0.08	25	0
Body Weight (kliograms)	07	70	70	, t
Conversion Factor Averaging Time, years	1E-06	1E-06	1E-06	1E-06
Carcinogens	E	20	ç	F
Noncarcinogens	25	0.08	0. 0.	0/

SITE8A.WB1/ 940127

TABLE V-27 DAILY INTAKE - ADULT SOIL INGESTION CURRENT LAND USE SCENARIO -FACILITY EMPLOYEE

Noncarchogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Chemical	Hottertagono	COUNEISION		Fraction	Exposure	Exposure	Body	Average	
NOO	CONTRACTOR	Rate Ing	Ingestion Rate	Ingested	Frequency	Duration	Weight	Time	intake Rate
Aug	(mg/kg)		(mg/day)	(unitless)	(days/year)	(years)	(kg)	(days)	(mg/kg-day)
	5.100E+00	1E-06	100		250	25	70	9125	4.990E-06
	4.260E+01		100	-	250	25	7.0	9125	4.168E-05

SITE8A.WB1/ 940127

E V-28 DAILY INTAKE - ADULT SOIL INGESTION	CURRENT LAND USE SCENARIO - FACILITY EMPLOYEE
TABLE	

	Intake Rate	(mg/kg-day) 1.782E-06 1.489E-05
	Average	(days) 25550 25550
	Body Weight	(kg) 70 70
	Exposure Duration	(Years) 25 25
	Exposure	(days/yea) 250 250 250
	Fraction Ingested	
	Conversion Rate ingestion Rate (mol/day)	1E-06 100
Carcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, Mi	Chemical Concentration (mg/kg)	5.100E+00 4.260E+01
Carcinogenic Eff Site 8, Former Si	Chemical	Anumony Lead

SITE&A.WB1/ 940127

		- EXCAVATION WORKERS
: V-28 DAILY INTAKE - ADULT	SOIL INGESTION	FUTURE LAND USE SCENARIO - EXCAVATION WORKERS
TABLE		

Chemical	Chemical Concentration (mg/kg)	Conversion Rate Ingestion Rate (mg/day)	Fraction Ingested (unifless)	Exposure Frequency (davs/vear)	Exposure Duration (vears)	Body Weight	Average Time	Intake Rate
Antimony	5,100E+00	1E-06 480		250	0.08	70	29.2	2.395E-0
Dea	4.Z60E+01		-	250	0.08	70	29.2	2,001E-0

TABLE V-30 DAILY INTAKE - ADULT 30IL INGESTION FUTURE LAND USE 3CENARIO - EXCAVATION WORKERS

Carchogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Intake Rate	(mg/kg-day) 2.737E-08 2.287E-07
Average Time	(talys) 25550 25550
Body Weight	70 70 70
Exposure Duration	0.08
Exposure Frequency (davs/war)	250 250 250
Fraction Ingested (unitless)	
ngestion Rate (mg/day)	480
_	1E-06
Chemical Concentration (mg/kg)	5,100E+00 4,260E+01
Chemical	Anlinony Lead

TABLE V-31 DAILY INTAKE - ADULT SOIL INGESTION FUTURE LAND USE SCENARIO - RECREATIONAL ADULT

Noncarchogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

5,10E+00 1E-06 100 1 298 25 70 9125 5,48E-06 4,260E+01 1E-06 100 1 298 25 70 9125 4,599E-05	1E-06 100 1 298 25 70 9125 1E-06 100 1 298 25 70 9125	1E-06 100 1 298 25 70 9125	1E-06 100 1 298 25 70 9125	1E-06 100 1 298 25 70 9125
1E-06 100 1 298 25 70 9125	1E.06 100 1 298 25 70 9125	1E-06 100 1 298 25 70 9125	1E.06 100 1 298 25 70 9125	1E.06 100 1 298 25 70 9125

TABLE V-32 DAILY INTAKE - CHILD SOIL INGESTION FUTURE LAND USE SCENARIO - RECREATIONAL CHILD

Noncarcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

in law in the second									
	Chemical	Conversion		Fraction	Exposure	Exposure	Body	Average	
Chemical	Concentration	Rate	Rate Ingestion Rate	Ingested	Frequency	Duration	Weight	TIme	Intake Rate
	(mg/kg)		(mg/day)	(unitiess)	(days/year)	(years)	(kg)	(days)	(mg/kg-day)
Antimony	5.100E+00	1E-06	200	-	48	9	15	2190	8.942E-06
Lead	4.260E+01	90-31	200	-	48	9	15	2190	7.470E-05

TABLE V-33 DAILY INTAKE - ADULT SOIL INGESTION FUTURE LAND USE SCENARIO - RECREATIONAL ADULT

Carcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Paraction Praction

TABLE V-34 DAILY INTAKE - CHILD SOIL INGESTION FUTURE LAND USE SCENARIO - RECREATIONAL CHILD

Carcinogenic Effect Exposure Assessment

	Intake Rate	(11) 14 (14) 15 (16) 16 (16) 1	
	Average Time	25550 25550 25550	
	Body Weight	5 5 5	
	Exposure Duration (vears)	9 9	
	Exposure Frequency (days/year)	4.8	
	Fraction ingested (uniffess)		
	ngeston Rate (mg/day)	200	
	Conversion Rate In	1E-06 1E-06	
Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, Mi	Chemical Concentration (mg/kg)	5.100E+00	
Site 8, Former SI	Chemical	Anilmony Lead	

TABLE V-36 EXPOSURE ASSESSMENT PARAMETERS - SOIL INHALATION Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

PARAMETER	EXCAVATION WORKER
Inhalation Rate, (mg/cu m)	20
Exposure Time (hours/day)	Φ
Exposure Frequency (days/year)	250
Exposure Duration (years)	0.08
Body Weight (kilograms)	20
Averaging Time (years)	
Carcinogens	70
Noncarcinogens	0.08

SITE8A.WB1/ 940127

TABLE V-36 DAILY INTAKE - ADULT SOIL INHALATION FENDERS FUTURE LAND USE SCENARIO - EXCAVATION WORKERS

Noncarcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Intake Rate	6.669E-04
Time	29.2
Weight (kg)	07 70
Exposure Frequency (days/vr)	250
Exposure Time (hours/dav)	ω ω
	20 20
Exposure Duration (years)	
Concentration (mg/cu m)	5.100E-05 4.260E-04
Chemical	Antimony Lead

V-37 DAILY INTAKE - ADULT SOIL INHALATION FOR SOIL INHALATION FOR SCENARIO - EXCAVATION WORKERS TABLE

Carcinogenic Effect Exposure Assessment Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

		Exposure	Inhalation	Exposure	Exposure			
Chemical	Concentration	Duration	Rate	Time	Frequency	Weight	Time	Intake Rate
	(mg/cn m)	(years)	(cn m/hr)	(hours/day)	(days/yr)	(kg)	(days)	(mg/kg-day)
Antimony	5.100E-05	0.08	20	8	250	70	25550	9.125E-08
Lead	4.260E-04	0.08	20	80	250	20	25550	7.622E-07

SITE8A.WB1/940127

TABLE V-38 SOIL INHALATION MODEL CALCULATIONS Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Construction work		
Dust Loading Factor (g/m^3) Conversion Factor	0.000	g/gm B/gm
Computations C(i), mg/kg W(i)/W, g/g C(air), mg/m^3	Antimony 5.1 5.1E-05 3.06E-05	Lead 42.6 4.26E-04 2.56E-04

TABLE V-39 SOIL INHALTION MODEL CALCULATIONS Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Construction traffic			
Dust Loading Factor (g/m^3) Conversion Factor	0.000	g/m^3 mg/g	
Computations C(i), mg/kg W(i)/W, g/g C(air), mg/m^3	Antimony 5.1 5.1E-05 2.04E-05	Lead 42.6 4.26E-04 1.70E-04	

SITE8A.WB1/ 940127

TABLE V40 CANCER ESTIMATE - GROUNDWATER INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Carcinogenic Effects Site 8, Former Site of F	Carclnogenic Effects Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI	S, Apena, MI									
Chemical	Adult CDI (mg/kg-day)		CDI Adjusted for Absorption	CDI SF Weight o Adjusted for (mg/kg-day)^1 EWdenco Absorption	Weight of Evidence	Type of Cancer	SF Source	Adult Chemical- Specific Risk	Totał Pathway Risk	Children Chemical- Specific Risk	Total Pathway Risk
Tetrachloroethylene	6,729E-06	တ္	O _N	0.051	82	Liver	CA EPA, 92	3E-07		9E-08	
Total											

TABLE V41 CHRONIC HAZARDOUS INDEX ESTIMATE - GROUNDWATER INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncarcinogenic Effects Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, Mi

								Advilt		Children	
Chemical	Adult CDI (mg/kg-day)	Child CDI (mg/kg-day)	CDI Adjusted for Absorption	RfD (mg/kg-day)	Ortifical Effect	RfD Source	Modifying Factor	Chemical- Specific Risk	Total Pathway Risk	Chemical- Specific Risk	Total Pathway Risk
refrachloroethy/ene	1,884E-05	7.868E-06	ON	0.01 · H	0.01 · Hepatotoxicity	IRIS, 1993		2E-03		8E-04	
Total									2E-03		8E-04

TABLE V-4. CANCER ESTIMATE - GROUNDWATER INHALATION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Carcinogenic Effects Site 8, Former Site of Hangar 8, Alpena CRTC, Alpena, Mi

Chemical	Adult CDI (mg/kg-day)	Child (mg/	CDI Adjusted for Absorption	SF (mg/kg-day)^-1	Weight of Evidence	Type of Cancer	SF Source	Adult Chemical- Specific Risk	Total Pathway Risk	Child Chemical- Specific Risk	Total Pathway Risk
letrachioroemyene Totai	Z.28BE-06	6 5.734E-07	C Z	0.0018		Leukemla, Liver	CA EPA, 92	4E-09		1E-09	

TABLE V44 CHRONIC HAZARDOUS INDEX ESTIMATE - GROUNDWATER INHALATION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncarcinogenic Effects Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Oric of Louisia	City of 1 city of 1 minger 3, A Jelia City C, Pelia, IVI	C, Aleila, IVII									
Chemical	Adult CDI (mg/kg-day)	Ĕ	CDI Adjusted for Absorption	RfD (mg/kg-day)	Critical Effect	RTD Source	Modifying Factor	Adult Chemical- Specific Risk	Total Pattiway Risk	Children Chemical- Specific Risk	Total Pathway Risk
retrachloroethylene	6.407E-06	2.676E-06	ON	0.01	NA	ΑΝ	NA	6E-04		3E-04	
Total							,		20		Ĺ

¹⁾ RfD for corresponding chronic oral RfD use.

TABLE V45 CANCER ESTMATE. DERMAL CONTACT WITH GROUNDWATER FUTURE LAND USE SCENARIO. ADDLITS AND CHILDREN

00 11000	Adjusted for Absorption	SF SF	Weight of	Type of	a.	Adult Chemical- Specific	Total Pathway	Oviid Ohemical- Specific	Total Pathway
6.527 E-06 1,121 E-06	YES	0.051	Evocrice B22	Liver	Source CA EPA, 92	78.5K 3E-07	₩ ₩	R39K 6E-08	전 2

Adjusted from administered to absorbed using and absorption efficiency of 100%.

TABLE V46 CHRONIC HAZARDOUS INDEX ESTIMATE - DERMAL CONTACT WITH GROUNDWATER FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noroardinogeric Effects Site 8, Former Site of Hangar 9, Alpena CRTC, Alpena, MI

Office, I Chille Office Co.	are of rainer are or reage of Apara Civillo, Apara, will	י ישומי ואון									
Chemical	Adult CDI (mg/kg-day)	Adult Child CDI CDI (mg/kg-day)	CDI Adjusted for Absorption	RfD* (mg/kg·day)	Critical Effect	RID Source	Modifying Factor	Adult Chemical- Specific Risk	Total Pathway Risk	Child Chemical- Specific Risk	Total Pathway Risk
Tetrachloroethylene	1.828E-05	5.232E-06		0,01	Hepatratoxicaty	IRIS, 1993	_	2E-03		5E-04	
R C									, n		i d

Adjusted from administered to absorbed using and absorption efficiency of 100%.

	EXCRANGION MACINEMINA	THE PRINCE NAME OF											
hemical	Worker CDi (mg/kg-dwy)	Adult CDI (mg/kg-dey)	CDIIQ CDi (mg/kg-dey)	CDI Adjusted for Absorption (n	SF (ma/ka-day)^-1		Weight of Endenge	Type of	S. F.	Excevedon Chemical- Specific	Total Pothway	Adult Chemical- Specific	Total Pathway
Anthrocy end	4.928E-09 4.117E-08	4 929E-09 1,836E-05 4.117E-08 1,534E-05	2 197E-07 1.835E-06	YES	NO EMDENCE NO DATA	B2		Klahey	Source	96 96 96 96 96	MISK	MSK 0E-400 0F-400	¥ .

TABLE V48 SUBCHRONIC HAZARDOUSINDEX ESTIMATE. DERMAL CONTACT WITH SOILS FUTURE LAND USE SCENARIO
NOCEMICOSINE THEST
CONTROL OF STATEMENT OF STATEMEN

Site 8, Former Site	Site 8, Former Site of Hanger 9, Alpena CRTC, Alpena, M	, Alpene, M													
	Excevelor Worker CDI	Adult	Child	d CDI	Subchronic RFO*	Chronic	10 ST O	Ç.	Medibing	Excevetion Chemical- Specific	Total	Adult Chemical-	Total	Chemical-	Toba
Chemical	(Mg/kg-day)	(mg-gwgm)	(Mg/kg-day)	Absorption	(mg/kg-dry)	(Mg/kg-dmy)	Effect	Source	Factor	Risk	Risk	NEW YEAR	Risk	Risk	Risk
Antimony	4 313E-06	5.141E-08	1.025E-06	YES	2E-05	2E-06	Reduced Lifespen	INS 90		2E-01		35-01		SE-02	
Lend	3.802E-05	4.294E-05	8.56/E-06	YES	100	0.01	UNer	HEAST FY93	-	AE-CO		4E-03		46.00	

PLOYEE		
ME STEEM		
H SOLS .		
BLE: V-48 CARCER ESTIMATE: DERMAL CONTACT WITH SOILS - DN-SITE EMPLOYEE	OIS	
MATE	CURRENT LAND USE SCENARIO	
NCER ES	IT LAND US	
	CURREN	
10		

10 m	Add Add (CD) (CD) (CD)	CDI Adjusted for Absorption	SF (mq/kq-d e v/)1		Weight of Foldence	Type of	SF	Aduit Chemical- Specific	Total Pathway
	1.540E-05 1.287E-15	YES	NO EVIDENCE NO DATA	82		Kldney	A.150.5	0E+00 0E+00	

TABLE V-30 SUBCHRONIC HAZANDOUS INDEX ESTIMATE - DERMAL CONTACT WITH SOILS - ON-SITE EMPLOYEE CURRENT LAND USE SCENARIO

1	Adult	Adjusted for		Critical
Antimony	4.313€-06	YES	(mg/mg/mg/cosy)	Reduced I Factor
	3.602E-05	YES		Uver

Adult Chemical-Specific Risk 2E-01 4E-03

> ModPying Factor

Source IRIS 93 HEAST FY93

> Tobal 787 0 equitad from administered to absorbed dose using an absorption efficiency of 5%.

Vydrker Adult Child (20) CDI CON CDN Adjusted for					The second secon		
	on the state of th	1		E-CAVATION Chemic≣-	ADULT Chemical-	Chemical	Ţ
Absorption (mp	e overpos	Carrier	Source	Specific	Specific	Specific	Pathway
2.555.07 1.755.05 P.019.430	16	Sempre		(F+0)	0.+00	01+30	4

time to the second second second	PUTURE LAND USE SCENARIO	

hemcel	Exceptedon VAPrings CDI (mg/kg-day)	Exceptation Adult Worker Adult CDI CDI (mg/kg-dey) (mg/kg-dey) (Child CDi (mg/kg-d a)	Cf.y Adjutted for Absorption	(/wp-by/bu)	Shore Se	imedical formula	RM5 Source	Modifying Factor	CVACUATION Chemical Secrito Prop	Total Pathway Pisk	ADUCT Chemical- Specific Risk	Total Pathwey Risk	CHILD Chemcal- Specific Risk	Pathway Pist
Antimony Lead	2 44E-45 2 00E-04	51451,00 4.000[5.05	60ALF-00 7-470E-05		0.000 Po (AfA	DRAM	reduced integral	HEACH FYOR	-	&: :5		15-02		3C40	
3															

		30
		(C)
TABLE V-43 CARCER SETWATE-604 (BDESTOR CURRERT LABD VSE SCREARIO - PACILITY ENPLOYES	Carcinogene Effects Site B, Former Site of Hangar B, Alpana CRTC, Alpana, MI	FALLIN'S EMPLOYER CN

Total Pathway Risk		8
Chamcal- Specific Specific Risk	©+;D	
\$5. S.		
Type of Carcer	Ridney	
Waight of Endance	83	
(1) Adustrial (1) (2) (3) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4	1: PATA	
Adjusted for Absorption	£	
EMPLOYFE CDI (mp/g-dm/)	1.4896:405	

Chemical	(Applyou)	Adjusted for Absorbing	(Aug-Bayem)	intotal Firect	RMD Source	Modifying Factor
λ	1 meas	CW	NOTALA	uedse/1 peunpeg	HEAST CYRS	

Pathway Risk

ADULT Chemicalis Specific Risk

SITE8A WB1/640127

TABLE V-55 CANCER ESTIMATE - SOIL INHALATION FUTURE LAND USE SCENARIO - EXCAVATION WORKER

Chemical	Excavation CDI (mg/kg-day)	CDI Adjusted for Absorption	SF (mg/kg-day)^1	Weight of Evidence	Type of Carcer	n F	Excavation Chemical- Specific Dask	Total
<u>k</u>	9 1/2E-08 7 622E-07	CZ N	NO EVIDENCE NO DATA	B2	NA		0E+00 0E+00	2

TABLE V-56 SUBCHRONIC HAZARDOUS INDEX ESTIMATE - SOIL INHALATION FUTURE LAND USE SCENARIO - EXCAVATION WORKER

	ido	Adjusted for	RfD Tr	Critical
Chemical	(mg/kg-day)	Absorption	(mg/kg-day)	Effect
imorry	7.984E-05	ON	0.0004	٨Z
P	6.669E-04	ON	NO DATA	

Total Pathway Risk

Excavation Chemical-Spedific Risk 2E-01

> Modfying Factor NA NA

Source IRIS 93 2E-01

^{*} RfD converted for corresponding subchronic oral RfD was used.

Groundwater Solute Transport Model Data - Site 8

Theoretical Background

A two-dimensional Method of Characteristics (MOC) solute transport model (Konikow and Bredehoeft, 1989) was used for preliminary examination of contaminant migration within the shallow aquifer beneath the Alpena CRTC. The model is designed to calculate transient changes in solute concentrations within groundwater by simultaneously solving partial differential equations describing groundwater flow and transport and computes the change in a chemicals concentration over time. Changes in chemical concentrations over time are caused by the processes of convective transport, hydrodynamic dispersion, and mixing from fluid sources. This model couples the groundwater flow equation with solute transport equations.

The flow equation can be approximated by an implicit finite-difference equation. The model area is discretized into a rectangular grid with each square being a node. The finite difference equation is solved numerically for each node in the grid using an iterative alternating-direction implicit (ADI) procedure.

After the hydraulic head distribution is calculated, the velocity of groundwater flow can be computed at each node. The expression for average velocity of groundwater can be derived from Darcy's law. The groundwater velocity at each node is calculated utilizing an explicit finite-difference approximation of Darcy's law. The computer program uses an alternating-direction implicit procedure to solve a finite-difference approximation to the groundwater flow equation, and it uses the method of characteristics (MOC) to solve the solute transport equation. MOC uses a particle tracking procedure to represent convective transport and a two-step, explicit procedure to solve a finite-difference equation that describes the effects of hydrodynamic dispersion, fluid sources and sinks, and divergence of velocity.

A number of assumptions are inherent in the solute transport model:

- 1. Darcy's law is valid and hydraulic head gradients are the only significant driving mechanism for fluid flow.
- 2. The porosity and hydraulic conductivity of the aquifer are constant with time, and porosity is uniform in space.
- 3. Gradients of fluid density, viscosity, and temperature do not affect the velocity distribution.
- 4. No chemical reactions occur that affect the concentration of the solute, the fluid properties, or the aquifer properties.
- 5. Ionic and molecular diffusion are negligible contributors to the total dispersive flux.
- 6. Vertical variations in head and concentrations are negligible.

7. The aquifer is homogeneous and isotropic with respect to the coefficients of longitudinal and transverse dispersivity.

Transport Model Input

A model grid of 32 columns by 19 rows with a 250 foot lateral spacing was used. Specified head cells were used at nodes corresponding to the South Branch of the Thunder Bay River, at nodes along the eastern boundary of the model grid area, and also at the sinkhole in the northeastern portion of the model. Groundwater elevations measured during September, 1993 were used as initial input into the transport model. Hydraulic conductivity values were calculated from slug tests performed at Alpena CRTC (Engineering Science, 1989; Earth Technology, 1994). Values of hydraulic conductivity range from 12 feet/day at Site 4 to 278 feet/day at Site 3.

Aquifer thickness values were obtained from drilling records of monitoring wells and soil borings obtained from the SI and RI field activities. Values listed are from logs in which the thickness of the shallow aquifer was clearly discernible, and ranged from 20 feet at Site 5 to 65 feet at Site 8. Transmissivity values were calculated by multiplying the calculated hydraulic conductivity values by the aquifer thickness. Transmissivity ranges from 420 ft²/day at TF4-MW3 to 15,290 ft²/day at CG3-MW5.

Monitoring of the discharge of springs into the sinkhole was performed during the SI (Engineering Science, 1990) and an estimate of approximately 18,000 gallons of water per day discharging into the sinkhole was calculated. In order to obtain a numerical estimate of discharge into the sinkhole for the model, MODFLOW (McDonald and Harbaugh, 1988), a 3- dimensional finite-difference groundwater flow model was used. MODFLOW was used because of its ability to simulate the effect of head-dependent groundwater flow into a groundwater sink (i.e. the sinkhole). This package was not available in MOC. The same model parameters and boundary conditions were used within MODFLOW as in MOC. Based upon hydraulic head data collected in September 1993, discharge from the shallow aquifer into the sinkhole is approximately 30,000 gallons per day.

The dispersivity of an aquifer in two dimensions is described by the longitudinal dispersion, the transverse dispersion and the ratio of the two (Fetter, 1993). As a contaminant plume moves further from its initial location within the aquifer by advection with the groundwater flow, the plume spreads. The spreading in the direction of groundwater flow is the longitudinal dispersion, the spreading in the direction perpendicular to the groundwater flow is known as the transverse dispersion (Fetter, 1993). The values of the dispersion coefficients are typically derived via bench scale tests, aquifer tests, or calibration of contaminant transport models. Since no data presently exists describing dispersivity within the shallow aquifer beneath the Alpena CRTC and insufficient data exists to allow for derivation of dispersivity via model calibration, moderate values of 100 feet for longitudinal dispersivity and 30 feet for transverse dispersivity were chosen (Gillham and Cherry, 1982). A more complete description of the model is given in the report, Preliminary Groundwater Modeling Effort, Earth Technology, August 1993.

Model Calibration:

The groundwater flow model was calibrated with respect to the September 1993 groundwater elevation measurements. Calibration of the groundwater flow model was accomplished by defining a set of parameters, boundary conditions, and stresses that produce simulated heads and fluxes that match field-measured values within a preestablished range of error (Anderson and Woessner, 1992). In order to match field measured values for hydraulic head as determined during September 1993, a few modifications were made to the preexisting groundwater flow model. These changes included updating the initial head array, modeling the sinkhole as a constant head cell to account for the large gradient changes in the vicinity of the sinkhole and including recharge to the model at a rate of 9 inches per year over the whole model area. By adjusting these parameters, an acceptable level of calibration was achieved. An acceptable level of calibration was defined as a root mean squared error (RMS) of less than 2 feet. The RMS, or the standard deviation is the average squared difference in measured and simulated heads and is given by the equation:

RMS=
$$\left[1/n\sum_{i=1}^{n} (h_m - h_s)_{i}^{2}\right]^{0.5}$$

n = number of wells $h_m = measured head$ $h_s = model simulated head$

Certain portions of the model may have values above the goal of 2 feet while others fall much below this value. The RMS represents the average error present in the model. The following provides a summary of the final calibrated heads for the flow model.

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
MP2MW1	10,25	679.69	676.68	3.01
MP2MW3	10,22	675.51	675.46	0.05
MP2MW4_5*	11,23	675.34	675.70	-0.36
MP2MW6	11,20	674.86	674.52	0.34
CG3MW1	6,24	677.38	676.69	0.69
CG3MW2	7,22	676.29	675.78	0.51
CG3MW3	9,23	676.50	675.98	0.52
CG3MW4_5*	8,23	676.41	676.08	0.33

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
CG3MW7	8,20	675.64	674.80	0.84
TF4MW1	7,9	667.23	668.83	-1.60
TF4MW2	8,10	659.61	664.22	-4.61
TF4MW3_4*	9,10	658.21	660.06	-1.85
SF5MW1	12,6	674.15	671.34	2.81
SF5MW2	14,5	675.32	672.67	2.65
SF5MW3_4*	13,6	676.46	671.64	4.82
SF5MW6	13,5	674.26	672.40	1.86
LF6MW1	14,9	672.1	670.40	1.70
LF6MW2	14,8	672.68	670.72	1.96
LF6MW3	14,10	671.93	670.21	1.72
LF6MW4	16,7	672.75	671.91	0.84
LF6MW5	15,7	673.07	671.56	1.51
LF6MW6	13,10	671.17	669.67	1.50
LF6MW8	15,9	673.12	670.78	2.34
HN8MW1	5,22	676.96	675.93	1.03
HN8MW2	6,19	675.31	674.50	0.81
HN8MW3_4*	7,21	676.01	675.35	0.66
RT9MW1	6,16	673.06	672.78	0.28
RT9MW2	7,14	668.21	670.81	-2.60
RT9MW3	9,15	670.72	671.26	-0.54
RT9MW4_5*	8,14	667.47	670.32	-2.85
RT9MW6	8,16	670.58	672.33	-1.75
S1MW2	13,26	677.39	676.63	0.76
S1MW3	13,27	677.15	676.98	0.17
S1MW11	15,24	675.72	675.67	0.05
S1MW12	16,25	674.55	675.94	-1.39

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
S1MW13	14,24	675.21	675.76	-0.55
S1MW14	14,25	673.92	676.14	-2.22
MP2MW2	12,24	675.57	675.96	-0.39

^{*} Indicates that more than one well is present in each node and an average value for hydraulic head was used.

Sum of Squared Residuals = 128.78/38 = 3.3891 Root Mean Squared Error = 1.84

It should also be noted that the model was calibrated with respect to the September 1993 water level data and should only be considered calibrated with respect to this data. More information on the water level fluctuation through time would be needed to perform a transient calibration. The model was not calibrated with respect to concentration data, but only with respect to hydraulic head.

Model Assumptions and Limitations

- * The model domain consisted only of the shallow unconfined aquifer (i.e. one layer).
- * The initial head data input to the transport model are results of measurements taken in September 1993.
- * Initial concentrations of compounds are results of the Round IV sampling event which was conducted from July to September 1993.
- * Hydraulic conductivity values are the result of slug tests performed in November, 1987 and September 1993.
- * The model was calibrated with respect to hydraulic head using September 1993 water level data and should only be considered calibrated with respect to September 1993 water level data.
- * The flow model was assumed to be at steady-state with respect to hydraulic head.

Site 8

PCE was present in well HN8MW8 above MDNR Type B cleanup criteria at a concentration of 1.2 ug/l. This data was input to the model and concentrations at the sinkhole were monitored with respect to time.

Appendix W: Site 9 Risk Assessment

Table W-1A

Data Utilized to Calculate Reasonable Maximum Exposure Concentrations for Groundwater - Site 9

MIANG, Alpena CRTC, Alpena, MI

SITE	LOCATOR	SAMPLE ID	MATRIX	ANALYTE	RESULT
PC-RT9	MW1	PC-RT9-MW1-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-RT9	MW2	PC-RT9-MW2-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-RT9	MW3	PC-RT9-MW3-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-RT9	MVV4	PC-RT9-MW4-GW4	GROUNDWATER	1,4-Dichlorobenzene	0.0750
PC-RT9	MW6	PC-RT9-MW6-GW4	GROUNDWATER	1,4-Dichlorobenzene	18.0000
PC-RT9	MW1	PC-RT9-MW1-GW4	GROUNDWATER	2-Methylnaphthalene	2.5000
PC-RT9	MW2	PC-RT9-MW2-GW4	GROUNDWATER	2-Methylnaphthalene	2.5000
PC-RT9	MW3	PC-RT9-MW3-GW4	GROUNDWATER	2-Methylnaphthalene	2.5000
PC-RT9	MW4	PC-RT9-MW4-GW4	GROUNDWATER	2-Methylnaphthalene	2.5000
PC-RT9	MW5	PC-RT9-MW5-GW4	GROUNDWATER	2-Methylnaphthalene	2.5000
PC-RT9	MW6	PC-RT9-MW6-GW4	GROUNDWATER	2-Methylnaphthalene	47.0000
PC-RT9	MW1	PC-RT9-MW1-GW4	GROUNDWATER	Benzene	0.1750
PC-RT9	MW2	PC-RT9-MW2-GW4	GROUNDWATER	Benzene	0.1750
PC-RT9	MW3	PC-RT9-MW3-GW4	GROUNDWATER	Benzene	0.1750
PC-RT9	MW4	PC-RT9-MW4-GW4	GROUNDWATER	Benzene	0.1750
PC-RT9	MW5	PC-RT9-MW5-GW4	GROUNDWATER	Benzene	0.1750
PC-RT9	MW6	PC-RT9-MW6-GW4	GROUNDWATER	Benzene	3.9000
PC-RT9	MW1	PC-RT9-MW1-GW4	GROUNDWATER	Lead, Dissolved	1.0000
PC-RT9	MW2	PC-RT9-MW2-GW4	GROUNDWATER	Lead, Dissolved	1.0000
PC-RT9	MW3	PC-RT9-MW3-GW4	GROUNDWATER	Lead, Dissolved	1.0000
PC-RT9	MW4	PC-RT9-MW4-GW4	GROUNDWATER	Lead, Dissolved	1.0000
PC-RT9	MW5	PC-RT9-MW5-GW4	GROUNDWATER	Lead, Dissolved	1.0000
PC-RT9	MW6	PC-RT9-MW6-GW4	GROUNDWATER	Lead, Dissolved	15.9000
PC-RT9	MW1	PC-RT9-MW1-GW4	GROUNDWATER	Tetrachloroethylene	1.0000
PC-RT9	MW2	PC-RT9-MW2-GW4	GROUNDWATER	Tetrachloroethylene	0.1500
PC-RT9	MW3	PC-RT9-MW3-GW4	GROUNDWATER	Tetrachloroethylene	0.1500
PC-RT9	MW4	PC-RT9-MW4-GW4	GROUNDWATER	Tetrachloroethylene	1.7000
PC-RT9	MW5	PC-RT9-MW5-GW4	GROUNDWATER	Tetrachloroethylene	0.1500
PC-RT9	MW6	PC-RT9-MW6-GW4	GROUNDWATER	Tetrachloroethylene	1,5000

TABLE W-1 EXPOSURE ASSESSMENT PARAMETERS - INGESTION OF GROUNDWATER Site 9, Radar Tower, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	CHILD
Ingestion Rate (L/day) Exposure Frequency (days/year) Exposure Duration (years) Body Weight, Kg Averaging Time Carcinogens Noncarcinogens	298 255 70 70 70	2.000 15 27 70
	67	<u>0</u>

TABLE W-2 DAILY INTAKE - ADULT INGESTION OF GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 9, Radar Tower, Alpena CRTC, Alpena, MI

	(hemical	nonetion	Evnociara	2,000	0.4.	A	
		III Bearing	CAposare	Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Direction	Weight	i i	4-0
			la l	Constitution	TI ACIDIA	9111	nate
	(J/Bm)	(L/day)	(days/year)	(vears)	(ka)	(davs)	(ma/Ka-dav)
Tetrachloroethylene	1.369E-03	2	298	25	02	9175	3 193E-05
				1)	0.4.0	0.1001.0
2-Methylnaphthalene	2.486E-02	2	298	25	2	9125	5 799F-04
A D: 11	CO LOCK P	•				1	
I,4-Uichioropenzene	1.130E-02	7	298	25	20	9125	2 637F-04
	CO 11000 C	•	4 4 4				
Benzene	5.800E-U3	7	298	52	20	9125	9 097F-05
	00 1107	•					
Lead, Dissolved	8.48/15-03	7	298	25	20	9125	1 980F-04

TABLE W-3 DAILY INTAKE - CHILD INGESTION OF GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 9, Radar Tower, Alpena CRTC, Alpena, MI

Chemical	Chemical Concentration (mg/kg)	Ingestion Rate (L/day)	Exposure Frequency (days/year)	Exposure Duration (vears)	Body Weight	Averaging Time	Intake Rate (ma/Ko-day)
Tetrachloroethylene 2-Methylnaphthalene 1,4-Dichlorobenzene Benzene	1.369E-03 2.486E-02 1.130E-02 3.900E-03	2.000 2.000 2.000	84 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	2	27 27 27 27	5475 5475 5475 5475	1.333E-05 2.422E-04 1.101E-04 3.799E-05
Lead, Dissolved	8.48/15-03	2.000	48	15	27	5475	8.268E-05

W-4 DAILY INTAKE - ADULT INGESTION OF GROUNDWATER FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 9, Radar Tower, Alpena CRTC, Alpena, MI

Chemical	Chemical Concentration	Ingestion Rate	Exposure Frequency	Exposure Duration	Body Weight	Averaging	Intake
	(l/bm)	(L/day)	(days/year)	(years)	(kg)	(days)	(mg/Kg-day)
Tetrachloroethylene	1.369E-03	2	298	25	70	25550	1 140E-05
2-Methylnaphthalene	2.486E-02	2	298	25	70	25550	2 071E-04
1,4-Dichlorobenzene	1.130E-02	7	298	25	20	25550	9 417F-05
Benzene	3.900E-03	7	298	25	02	25550	3 249F-05
Lead, Dissolved	8.487E-03	2	298	25	2	25550	7.071E-05

W-5 DAILY INTAKE - CHILD INGESTION OF GROUNDWATER FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 9, Radar Tower, Alpena CRTC, Alpena, MI

	Chemical	Ingestion		Exposure	Body	Averaging	Intake
Chemical	Concentration	Rate	Frequency	Duration	Weight	Time	Rate
	(mg/kg)	(L/day)	_	(years)	(ka)	(davs)	(ma/Ka-day)
Tetrachloroethylene	1.369E-03	2.000		15	27	25550	2 857F-06
2-Methylnaphthalene	2.486E-02	2.000	48	r.	27	25550	5 190F-05
1,4-Dichlorobenzene	1.130E-02	2.000	48	15	27	25550	2 359F.05
Benzene	3.900E-03	2.000	48	5	27	25550	8 141FLOS
Lead, Dissolved	8.487E-03	2.000	48	15	27	25550	1.777F-05

TABLE W-6 CALCULATIONS FOR GROUNDWATER INHALATION Site 9, Radar Tower, Alpena CRTC, Alpena, MI

				Showering Post Showering	+ Showering		Showering	Showering MAY
Chemicals	Chemical	Fraction	Water Flow	Duration	Duration	Bathroom	Contaminant	Contaminant
	Concentration	Volatilized	Rate	Period	Period	Volume	Concn'n in Air	Concn'n in Air
	(mg/L)	(unitless)	(L/hr)	(hr)	(hr)	(cn m)	(mg/cn m)	(ma/cn m)
Tetrachloroethylene	1.369E-03	0.7	750	0.25	0.35	11	1.633E-02	1.293E-02
2-Methylnaphthalene	0.000E+00	0.7	750	0.25	0.35	11	0.000E+00	0.000E+00
1,4-Dichlorobenzene	1.130E-02	0.7	750	0.25	0.35	11	1.349E-01	1.068E-01
Benzene	2.047E-03	0.7	750	0.25	0.35	11	2.442E-02	1.933E-02
ead, Dissolved	0.000E+00	0.7	750	0.25	0.35	11	0.000E+00	0.000E+00

TABLE W-7 EXPOSURE ASSESSMENT PARAMETERS - INHALATION OF GROUNDWATER Site 9, Radar Tower, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	CHILD
Exposure Time (hours/day)	0.120	0.120
Inhalation Kate (cu m/hr) Exposure Frequency (days/yr)	0.60 0 298	0.60 0 48
Exposure Duration (years) Body Weight, Kg Averaging Time (years)	25 70	15
Carcinogens Noncarcinogens	70 25	70 15

TABLE W-8 DAILY INTAKE - ADULT INHALATION OF GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 9, Radar Tower, Alpena CRTC, Alpena, MI

		Chemical	Inhalation	Exposure	Exposure	Exposure	Body	Averaging	Intake
Chemical		Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
		(mg/cn m)	(cn m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	(mg/Kg-day)
Tetrachloroethylene		1.293E-02	9.0	298	0.12	25	70	9125	1.086E-05
2-Methylnaphthalene	•	0.000E+00	9.0	298	0.12	22	20	9125	0.000E+00
1,4-Dichlorobenzene		1.068E-01	9.0	298	0.12	25	2	9125	8.966E-05
Benzene		1.933E-02	9.0	298	0.12	25	2	9125	1.624E-05
Lead, Dissolved	¢	0.000E+00	9.0	298	0.12	25	0/	9125	0.000E+00

* not VOCs

TABLE W-9 DAILY INTAKE - CHILD INHALATION OF GROUNDWATER FUTURE LAND USE SCENARIO

Noncarcinogenic Effect Exposure Assessment Site 9, Radar Tower, Alpena CRTC, Alpena, MI

olle 9, Nadai Tower, Alberta Chi C, Alberta, IVII	ver, Aibella en	C, Albeita, IVII	The second secon						
		Chemical	Inhalation	Exposure	Exposure	Exposure	Body	Averaging	Intake
Chemical		Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
		(mg/cn m)	(cn m/hr)	(days/year)	(hours/day)	(years)	(kg)	(days)	(mg/Kg-day)
Tetrachloroethylene		1.293E-02	0.600	48	0.12	15	27	5475	4.534E-06
2-Methylnaphthalene	*	0.000E+00	0.600	48	0.12	15	27	5475	0.000E+00
1,4-Dichlorobenzene		1.068E-01	0.600	48	0.12	15	27	5475	3.744E-05
Benzene		1.933E-02	0.600	48	0.12	15	27	5475	6.780E-06
Lead, Dissolved	*	0.000E+00	0.600	48	0.12	15	27	5475	0.000E+00
									_

* not VOCs

TABLE W-10 DAILY INTAKE - ADULT INHALATION OF GROUNDWATER FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 9, Radar Tower, Alpena CRTC, Alpena, MI

		Chemical	Inhalation	Exposure	Exposure	Exposure	Bodv	Averaging	Intake
Chemical		Concentration	Rate	Frequency	Time	Duration	Weight	Time	Rate
		(ma/cn m)	(cn m/hr)	(days/year)	(hours/day)	(years)	(ka)	(davs)	(ma/Ka-day)
Tetrachloroethylene		1.293E-02	9.0	298	0.12	25	70	25550	3 877E-06
2-Methylnaphthalene	*	0.000E+00	9.0	298	0.12	25	70	25550	0.000
1,4-Dichlorobenzene		1.068E-01	9.0	298	0.12	25	202	25550	3 202E-05
Benzene		1.933E-02	9.0	298	0.12	25	20	25550	5 799F-06
Lead, Dissolved	¢	0.000E+00	9.0	298	0.12	25	70	25550	0.000E+00

* not VOCs

TABLE W-11 DAILY INTAKE - CHILD INHALATION OF GROUNDWATER FUTURE LAND USE SCENARIO

Carcinogenic Effect Exposure Assessment Site 9, Radar Tower, Alpena CRTC, Alpena, MI

		Chemical	Inhalation	Exposure	Exposure	Exposure	Body	Averaging
		Concentration	Rate	Frequency	Time	Duration	Weight	Time
		(mg/cn m)	(cu m/hr)	(days/year)	(hours/day)	(vears)	(ka)	(days)
etrachloroethylene		1.293E-02	0.600	48	0.12	15	27	25550
2-Methylnaphthalene	*	0.000E+00	0.600	48	0.12	5	27	25550
1,4-Dichlorobenzene		1.068E-01	0.600	48	0.12	15	27	25550
		1.933 E- 02	0.600	48	0.12	15	27	25550
Lead, Dissolved	*	0.000E+00	0.600	48	0.12	15	27	25550

Intake Rate (mg/Kg-day) 9.715E-07 0.000E+00 8.023E-06 1.453E-06 0.000E+00

* not VOCs

TABLE W-12 EXPOSURE ASSESSMENT PARAMETERS - DERMAL CONTACT WITH GROUNDWATER Site 9, Radar Tower, Alpena CRTC, Alpena, MI

PARAMETER	ADULT	CHILD	
Skin Surface Area Available for Contact (sq cm)	19400	13300	
Exposure Time (hrs/day)	0.25	0.25	
Dermal Permeability Constant	0.00084	0.00084	
Exposure Frequency (days/year)	298	48	
Exposure Duration (years)	25	15	
Body Weight, Kg	70	27	
Averaging Time			
Carcinogens	70	20	
Noncarcinogens	25	131	
Conversion Factor	0.001		

^{*} Predicted PC (Table 5-7 of U.S. EPA, 1992a)

W-13 DAILY INTAKE - ADULT GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Noncarcinogenic Effect Exposure Assessment Site 9, Radar Tower, Alpena CRTC, Alpena, Mi

		Chemical	Dermal		Exposure	Exposure	Exposure	Body	Averaging	Conversion	deta
Chemical		Concentration	Permeability	Surface Area	Frequency	Тітв	Duration	Weight	Time	Factor	Rate
		(mg/l)	(cm/hr)	- 1	(days/year)	(hrs/day)	(years)	(ka)	(davs)	(//cn cm)	(ma/Kn-day)
Tetrachloroethylene	(a)	1.369E-03	0.4		298	0.25	25	70	9125	0.001	3 0075 05
2-Methylnaphthalene	(၁)	2.486E-02	0.001		298	0.25	35	202	9125	100.0	1 40eE 0e
1,4-Dichlorobenzene		1.130E-02	0.00084		298	0.25	25	2.2	9125	2000	F 374E 07
Benzene	(8)	3.900E-03	0.1		298	0.25	25	2.5	9125	2000	10.01 TO
Lead, Dissolved	(8)	8.487E-03	0.000004		298	0.25	25	202	9125	0.00	1 920E-03
											2010:

(a) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992a).
(c) Experimentally measured PC value for water, used in the absence of chemical specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).

W-14 DAILY INTAKE - CHILD GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Noncarcinogenic Effect Exposure Assessment Site 9, Radar Tower, Alpena CRTC, Alpena, MI

		Chemical	Dermal		Exposure	Exposure	Exposure	Body	Averaging	Conversion	Intake
Chemical		Concentration	Permeability	Surface Area	Frequency	Tirne	Duration	Weight	Time	Factor	Rate
		(mg/l)	(cm/hr)	ì	(days/year)	(hrs/day)	(years)	(ka)	(davs)	(I/cn cm)	(mo/Ka-day)
Tetrachloroethylene	(a)	1.369E-03	0.4		48	0.25	15	27	5475	0 001	8 REFE JOE
2-Methylnaphthalene	(၁)	2.486E-02	0.001		48	0.25	15	27	5475	0 001	4 026E-07
1,4-Dichlorobenzene		1.130E-02	0.00084		48	0.25	15	27	5475	0.00	1 538E-07
Benzene	(a)	3,900€-03	0.1	13300	48	0.25	15	27	5475	0.001	8 316F.06
Lead, Dissolved	(a)	8.487E-03	0.000004	13300	48	0.25	15	27	5475	0.001	5.498E-10

(a) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992a).
(c) Experimentally measured PC value for water, used in the absence of chemical specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).

W-15 DAILY INTAKE - ADULT GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 9, Radar Tower, Alpena CRTC, Alpena, MI

		Chemical	Dermai		Exposure	Exposure	Exposure	Body	Averaging	Conversion	Intake
Chemical		Concentration	Permeability	Surface Area	Frequency	Time	Duration	Weight	Time	Factor	Rate
		(l/bm)	(cm/hr)		(days/year)	(hrs/day)	(years)	(kg)	(days)	(I/cn cm)	(mg/Kg-day)
Tetrachloroethylene	(B)	1.369E-03	0.4		298	0.25	25	70	25550	0.001	1.106E-05
2-Methylnaphthalene	(i)	2.486E-02	0.001		298	0.25	25	70	25550	0.001	5.023E-07
1,4-Dichlorobenzene	•	1.130E-02	0.00084		298	0.25	25	20	25550	0.001	1.918E-07
Велгеле	(B)	3.900E-03	0.1		298	0.25	25	70	25550	0.001	7.879E-06
Lead, Dissolved	(a)	8.487E-03	0.000004		298	0.25	25	70	25550	0.001	6.859E-10

(a) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992a).
(c) Experimentally measured PC value for water, used in the absence of chemical specific experimental or predicted PC values (Table 5-3 of U.S. EPA, 1992a).

W-16 DAILY INTAKE - CHILD GROUNDWATER DERMAL CONTACT FUTURE LAND USE SCENARIO TABLE

Carcinogenic Effect Exposure Assessment Site 9 Radar Tower, Albena CRTC, Alpena, MI

		Chamical	Darmal	Skin	Fynosiira	Fxnosura	Fynosiira	Body	Averaging	Conversion	Intake
Chamical		Concentration	Permeability	Surface Area	Frequency	Time	Duration	Weight	ewil	Factor	Rate
		(mg/l)	(cm/hr)	(sq cm)	(days/year)	(hrs/day)	(years)	(kg)	(days)	(I/cn cm)	(mg/Kg-day)
Tetrachloroethylene	(8)	1.369E-03	0.4	13300	48	0.25	15	27	25550	0.001	1.900E-06
2-Methylnaphthalene	(0)	2.486E-02	0.001	13300	48	0.25	15	27	25550	0.001	8.628E-08
1.4-Dichlorobenzene	•	1.130E-02	0.00084	13300	48	0.25	15	27	25550	0.001	3.295E-08
Вапуапа	(B)	3.900E-03	0.1	13300	48	0.25	15	27	25550	0.001	1.353E-06
lead Dissolved	(a)	8.487E-03	0.000004	13300	48	0.25	15	27	25550	0.001	1.178E-10

(a) Experimentally measured PC (Table 5-3 of U.S. EPA, 1992a).

TABLE W-17 CANCER ESTIMATE - GROUNDWATER INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Carcinogonio Effocts Ste 9, Radar Tower, Alpera CRTC, Alpera, MI

Adult	Child	CDI Standard of the Standard o	Weight of	Type of	SF	Chemical- Specific	Total Pathway	Chemical. Spacific	Total
(mg/kg-day)	(mg/kg-day)	Absorption		CALCOL	Source	Risk	Risk	Risk	Risk
1.140E-05		9	B2	Liver	CA EPA 92	5 815E-07		4 4575 07	
2.071E-04						0.000F+00		0.0000	
9.417E-05		NO	82	Liver	HEAST 93	2 260F-06		5 663E-07	
3.249E-05	8.141E-06	ON ON	4	P Kerres	1000	0 4001 03		10-30000	
7.071E-05	1.772E-05	ON	B7	Kirkson	1000	9.4225-07		2.361E-0/	
				Y		O.GODE+00		0.000E+00	

TABLE W-18 CHRONIC HAZARDOUS INDEX ESTIMATE - GROUNDWATER INGESTION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncarcinogonie Effocts Ste 9, Radar Tower, Apera CRTC, Apera, MI

								1 1			
								Chemical	Total	Chamical	T
	Adult	Child	CDI	RID	Critical	RfD	Modifying	Specific	Pathway	Specific	Pathway
	CDI	CDI	Adjusted for	(mg/kg day)	Effact	Source	Factor	Rick	Biek	H.e.	Biek
Chemical	(mg/kg-day)	(mg/kg-day)	Absorption							2	4
Tetrachloroethylene	3,193E-05	1,333E-05	ON	0.01	Hepatotoxicity	IRIS 1993	Į	3 193F-03		1 333E-03	
-Methylnaphthalene	5.799E-04		ON	0.03		IRIS 1993	-	1 933F-02		8.073E-03	
1,4-Dichlorobenzene	2.637E-04		ON	NO DATA		AZ.	AN				
Зепгене	9.097E-05	3.799E-05	ON	NO DATA		₹ Z	AN				-
.oad, Dissolved	1.980E-04	8.268E-05	ON	NO DATA		¥ Z	AN				
Total									-		

¹⁾ Chronic RfD for pyrene was used.

TABLE W-19 CANCER ESTIMATE : GROUNDWATER INHALATION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

IN THE SAME OF THE						
Chamical Chamical The renchrotostylone 2-Methylmophtheliane 1,4-Dichlorobanzene Banzone Lead, Dissolved	Adult (201 (201 (201 (201 (201 (201 (201 (201	Child CD1 (mg/kg.day) (mg/kg.d	Absorption Absorption NO NO NO NO NO NO NO NO	SI (mg'kg day)* 1 NO EVIDE! I CE 0.029 NO DATA	Wongler of Evolution B2 C C R2 R2	Type of Canon Letenta Liver HA

Total Pathway Risk

Total Pathway Risk

Children Chemical Specific Risk 1749E-09 0.000E-00 3.209E-07 4.213E-08

Adut Chamical-Specific Risk 6.979E-09 0.000E+00 1.281E-06 1.682E-07 0.000E+00

> Source CA EPA 92 CA EPA 92 IRIS, 1993 NA

3.648E-07

1.456E-06

1) Inhalation SF converted from unit risk.

TABLE W-20 CHRONIC HAZARDOUS INDEX ESTIMATE - GROUNDWATER INHALATION FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Noncar cinogonic Effnets Ste 9, Radar Tower, Apera CRTC, Apera, Mi

nemical	Adult CDI (mg/kg-day)	Child CD1 (mg/kg-dny)	CDI Adjustari for Absorption	٤	Gutical Fifact	RID Source	Modifying Factor	Adult Chemical Specific Risk	Total Pathway Risk	Children Chemical- Spacific Risk	Total Pathway Risk
tractionsoentylene Methylnephthalene 1-Dicklotetherane nzene ed, Dissolved	1.085E-05 0.000E+00 8.965E-05 1.624E-05 0.000E+00		00000	0.01 0.03 0.2 NO DATA NO DATA	NA NA Liver, Kichey NA NA	IRIS 93 HEAST 93 NA NA NA NA	- 4 4 Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z	1.086E-03 0.000E+00 4.483E-04		4.534E-04 0.000E+00 1.872E-04	

¹⁾ RID for corresponding oral RID was used.

TABLE W.21 CANCER ESTIMATE - DERMAL CONTACT WITH GROUNDWATER FUTURE LAND USE SCENARIO - ADULTS AND CHILDREN

Careinogonic Effacts Site 9, Radar Tower, Alpena CRTC, Alpena, MI

								Adult		Child	
	Adult	Child	CD					Chemical-	total	Chemical.	Total
	CDI	Ē	Adjusted for	. Is	Weight of	Type of	SF	Spacific	Pathway	Specific	Pathway
Chamical	(Mg/kg-day)	kng/k	Absorption	(mg/kg day)* 1	Lvidence	Сансат	Source	Risk	Risk	Risk	Risk
Intrachloroathylene	1.106E-05	1.900E-0G	YES	0.051	E.	Liver	CA FPA 92	5 641F-07		9 689F.08	
2-Mathylnaphthalono	5 023E-07	8 628E-08	YES	NO EVIDENCE		:		0 000E+00		0 000E+00	
1,4-Dichlorobanzana	1 918E-07		YES	0.024	R2	Liver	HEAST 93	4 604F-09		7 908E-10	
Веплапе	7.879E-06	1.353E-06	YES	0.00	<	erkema	IRIS 1993	2 285E-07		1 925E.08	
Land, Dissolved	6.859E-10	1,178E-10	YES	NO DATA	82	Kichey		0.000E+00		0.000F+00	
Total									70,3779.7		1 3695.07

Adjusted from administered to absorbed using and absorption efficiency of PCE = 1, 1,4 DUB + 1, Panzena = 1, Lead = .05.

TABLE W 22 CHRONIC HAZARDOUS INDEX ESTIMATE. DERMAL CONTACT WITH GROUNDWATER FUTURE. LAND USE SCENARIO - ADULTS AND CHILDREN

Chemical-Specific Risk 8.87E-04 Total Pathway Risk 3.38E-03 Adult Chemical-Specific Risk 3.10E-03 2.81E-04 Modifying Factor Source IRIS, 1993 IRIS, 1993 Hepatotoxicity Critical Child CI34 (mg/kg-dm/) 8 868E-06 4 028E-07 1.538E-07 6.316E-06 5.498E-10 Noncarcinogenic Effects Site 9, Radar Tower, Alpera CRTC, Alpera, M. Adult CDI (mg/kg-day) 3.097E-05 1.097E-05 5.371E-07 2.206E-09 1.920E-09 Chamical
Tatrachloronthylana
2-Mathylanpitthalona
1,4-Dichlorotenzona
Barzana
Lead, Dissolved
Total

Total Pathway Risk

^{*} Adjusted from administered to absorbed using and absorption efficiency of , PCE = 1.0, 2-Methylnaphhalene = .017.

Groundwater Solute Transport Model Data - Site 9

Theoretical Background

A two-dimensional Method of Characteristics (MOC) solute transport model (Konikow and Bredehoeft, 1989) was used for preliminary examination of contaminant migration within the shallow aquifer beneath the Alpena CRTC. The model is designed to calculate transient changes in solute concentrations within groundwater by simultaneously solving partial differential equations describing groundwater flow and transport and computes the change in a chemicals concentration over time. Changes in chemical concentrations over time are caused by the processes of convective transport, hydrodynamic dispersion, and mixing from fluid sources. This model couples the groundwater flow equation with solute transport equations.

The flow equation can be approximated by an implicit finite-difference equation. The model area is discretized into a rectangular grid with each square being a node. The finite difference equation is solved numerically for each node in the grid using an iterative alternating-direction implicit (ADI) procedure.

After the hydraulic head distribution is calculated, the velocity of groundwater flow can be computed at each node. The expression for average velocity of groundwater can be derived from Darcy's law. The groundwater velocity at each node is calculated utilizing an explicit finite-difference approximation of Darcy's law. The computer program uses an alternating-direction implicit procedure to solve a finite-difference approximation to the groundwater flow equation, and it uses the method of characteristics (MOC) to solve the solute transport equation. MOC uses a particle tracking procedure to represent convective transport and a two-step, explicit procedure to solve a finite-difference equation that describes the effects of hydrodynamic dispersion, fluid sources and sinks, and divergence of velocity.

A number of assumptions are inherent in the solute transport model:

- 1. Darcy's law is valid and hydraulic head gradients are the only significant driving mechanism for fluid flow.
- 2. The porosity and hydraulic conductivity of the aquifer are constant with time, and porosity is uniform in space.
- 3. Gradients of fluid density, viscosity, and temperature do not affect the velocity distribution.
- 4. No chemical reactions occur that affect the concentration of the solute, the fluid properties, or the aquifer properties.
- 5. Ionic and molecular diffusion are negligible contributors to the total dispersive flux.
- 6. Vertical variations in head and concentrations are negligible.

7. The aquifer is homogeneous and isotropic with respect to the coefficients of longitudinal and transverse dispersivity.

Transport Model Input

A model grid of 32 columns by 19 rows with a 250 foot lateral spacing was used. Specified head cells were used at nodes corresponding to the South Branch of the Thunder Bay River, at nodes along the eastern boundary of the model grid area, and also at the sinkhole in the northeastern portion of the model. Groundwater elevations measured during September, 1993 were used as initial input into the transport model. Hydraulic conductivity values were calculated from slug tests performed at Alpena CRTC (Engineering Science, 1989; Earth Technology, 1994). Values of hydraulic conductivity range from 12 feet/day at Site 4 to 278 feet/day at Site 3.

Aquifer thickness values were obtained from drilling records of monitoring wells and soil borings obtained from the SI and RI field activities. Values listed are from logs in which the thickness of the shallow aquifer was clearly discernible, and ranged from 20 feet at Site 5 to 65 feet at Site 8. Transmissivity values were calculated by multiplying the calculated hydraulic conductivity values by the aquifer thickness. Transmissivity ranges from 420 ft²/day at TF4-MW3 to 15,290 ft²/day at CG3-MW5.

Monitoring of the discharge of springs into the sinkhole was performed during the SI (Engineering Science, 1990) and an estimate of approximately 18,000 gallons of water per day discharging into the sinkhole was calculated. In order to obtain a numerical estimate of discharge into the sinkhole for the model, MODFLOW (McDonald and Harbaugh, 1988), a 3- dimensional finite-difference groundwater flow model was used. MODFLOW was used because of its ability to simulate the effect of head-dependent groundwater flow into a groundwater sink (i.e. the sinkhole). This package was not available in MOC. The same model parameters and boundary conditions were used within MODFLOW as in MOC. Based upon hydraulic head data collected in September 1993, discharge from the shallow aquifer into the sinkhole is approximately 30,000 gallons per day.

The dispersivity of an aquifer in two dimensions is described by the longitudinal dispersion, the transverse dispersion and the ratio of the two (Fetter, 1993). As a contaminant plume moves further from its initial location within the aquifer by advection with the groundwater flow, the plume spreads. The spreading in the direction of groundwater flow is the longitudinal dispersion, the spreading in the direction perpendicular to the groundwater flow is known as the transverse dispersion (Fetter, 1993). The values of the dispersion coefficients are typically derived via bench scale tests, aquifer tests, or calibration of contaminant transport models. Since no data presently exists describing dispersivity within the shallow aquifer beneath the Alpena CRTC and insufficient data exists to allow for derivation of dispersivity via model calibration, moderate values of 100 feet for longitudinal dispersivity and $\overline{30}$ feet for transverse dispersivity were chosen (Gillham and Cherry, 1982). A more complete description of the model is given in the report, Preliminary Groundwater Modeling Effort, Earth Technology, August 1993.

Model Calibration:

The groundwater flow model was calibrated with respect to the September 1993 groundwater elevation measurements. Calibration of the groundwater flow model was accomplished by defining a set of parameters, boundary conditions, and stresses that produce simulated heads and fluxes that match field-measured values within a preestablished range of error (Anderson and Woessner, 1992). In order to match field measured values for hydraulic head as determined during September 1993, a few modifications were made to the preexisting groundwater flow model. These changes included updating the initial head array, modeling the sinkhole as a constant head cell to account for the large gradient changes in the vicinity of the sinkhole and including recharge to the model at a rate of 9 inches per year over the whole model area. By adjusting these parameters, an acceptable level of calibration was achieved. An acceptable level of calibration was defined as a root mean squared error (RMS) of less than 2 feet. The RMS, or the standard deviation is the average squared difference in measured and simulated heads and is given by the equation:

RMS=
$$\left[1/n\sum_{i=1}^{n} (h_{m}-h_{s})_{i}^{2}\right]^{0.5}$$

n = number of wells $h_m = measured head$ $h_s = model simulated head$

Certain portions of the model may have values above the goal of 2 feet while others fall much below this value. The RMS represents the average error present in the model. The following provides a summary of the final calibrated heads for the flow model.

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
MP2MW1	10,25	679.69	676.68	3.01
MP2MW3	10,22	675.51	675.46	0.05
MP2MW4_5*	11,23	675.34	675.70	-0.36
MP2MW6	11,20	674.86	674.52	0.34
CG3MW1	6,24	677.38	676.69	0.69
CG3MW2	7,22	676.29	675.78	0.51
свзммз	9,23	676.50	675.98	0.52
CG3MW4_5*	8,23	676.41	676.08	0.33

Well #	Row, Col	Measured Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
CG3MW7	8,20	675.64	674.80	0.84
TF4MW1	7,9	667.23	668.83	-1.60
TF4MW2	8,10	659.61	664.22	-4.61
TF4MW3_4*	9,10	658.21	660.06	-1.85
SF5MW1	12,6	674.15	671.34	2.81
SF5MW2	14,5	675.32	672.67	2.65
SF5MW3_4*	13,6	676.46	671.64	4.82
SF5MW6	13,5	674.26	672.40	1.86
LF6MW1	14,9	672.1	670.40	1.70
LF6MW2	14,8	672.68	670.72	1.96
LF6MW3	14,10	671.93	670.21	1.72
LF6MW4	16,7	672.75	671.91	0.84
LF6MW5	15,7	673.07	671.56	1.51
LF6MW6	13,10	671.17	669.67	1.50
LF6MW8	15,9	673.12	670.78	2.34
HN8MW1	5,22	676.96	675.93	1.03
HN8MW2	6,19	675.31	674.50	0.81
HN8MW3_4*	7,21	676.01	675.35	0.66
RT9MW1	6,16	673.06	672.78	0.28
RT9MW2	7,14	668.21	670.81	-2.60
RT9MW3	9,15	670.72	671.26	-0.54
RT9MW4_5*	8,14	667.47	670.32	-2.85
RT9MW6	8,16	670.58	672.33	-1.75
S1MW2	13,26	677.39	676.63	0.76
S1MW3	13,27	677.15	676.98	0.17
S1MW11	15,24	675.72	675.67	0.05
S1MW12	16,25	674.55	675.94	-1.39

Well #	Row, Col	Measured — Head (ft)	Simulated Head (ft)	Measured - Simulated Head (ft)
S1MW13	14,24	675.21	675.76	-0.55
S1MW14	14,25	673.92	676.14	-2.22
MP2MW2	12,24	675.57	675.96	-0.39

^{*} Indicates that more than one well is present in each node and an average value for hydraulic head was used.

Sum of Squared Residuals = 128.78/38 = 3.3891 Root Mean Squared Error = 1.84

It should also be noted that the model was calibrated with respect to the September 1993 water level data and should only be considered calibrated with respect to this data. More information on the water level fluctuation through time would be needed to perform a transient calibration. The model was not calibrated with respect to concentration data, but only with respect to hydraulic head.

Model Assumptions and Limitations

- * The model domain consisted only of the shallow unconfined aquifer (i.e. one layer).
- * The initial head data input to the transport model are results of measurements taken in September 1993.
- * Initial concentrations of compounds are results of the Round IV sampling event which was conducted from July to September 1993.
- * Hydraulic conductivity values are the result of slug tests performed in November, 1987 and September 1993.
- * The model was calibrated with respect to hydraulic head using September 1993 water level data and should only be considered calibrated with respect to September 1993 water level data.
- * The flow model was assumed to be at steady-state with respect to hydraulic head.

Site 9

Several chemicals were detected at Site 9 above MDNR Type A or Type B criteria. These chemicals include PCE, Benzene, 1,4- Dichlorbenzene, Lead, and 2- Methylnapthalene at concentrations of 1.5, 3.9, 18, 15.9, and 47 ug/l, respectively. These chemicals were all present at well RT9MW6, while PCE was detected in wells RT9MW4 and RT9MW5. However, due to numberical errors associated with the very large gradient changes near the sinkhole, PCE was only modeled in RT9MW6. The chemical data was input to the model at the node corresponding to well RT9MW6 and concentrations for the various analytes were monitored in the sinkhole with respect to time.